AR TARGET SHEET

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DOCUMENT #: DOE/RL-2004-14, Draft 1A

TITLE: Tanks/Lines/Pits/Boxes/Septic Tank & Drain Fields Waste Group OU RI/FS Work Plan and RCRA TSD Unit Sampling Plan

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DOE/RL-2002-14
Revision 1, Draft A

Tanks/Lines/Pits/Boxes/Septic Tank and Drain Fields Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan

Includes 200-IS-1 and 200-ST-1 Operable Units

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Assistant Secretary for Environmental Management

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Release Approval Date

APPROVAL PAGE

Title: Tanks/Lines/Pits/Boxes/Septic Tank and Drain Fields Waste Group Operable Units RI/FS Work Plan and RCRA TSD Unit Sampling Plan, Includes 200-IS-1 and 200-ST-1 Operable Units

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EXECUTIVE SUMMARY

This work plan supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) activities for the 200-IS-1 Tanks/Lines/Pits/Boxes Waste Group Operable Unit (OU) and the 200-ST-1 Septic Tanks and Drain Fields Group OU. As discussed in the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al. 2003b), the RI/FS work plan is prepared to present information on how the RI and FS processes will be conducted and eventually lead to proposed remedies for the waste sites in an OU. This work plan also integrates the *Resource Conservation and Recovery Act of 1976* (RCRA) facility investigation/corrective measures study (RFI/CMS) requirements for these OUs and utilizes the framework established in DOE/RL-98-28, Rev. 0, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, which is the implementation plan for integrating the RCRA treatment, storage, and disposal (TSD) unit closure process with the OU CERCLA RI/FS process. The RCRA TSD units included in this work plan will be investigated to comply with RCRA closure/post-closure requirements.

The 200-IS-1 and 200-ST-1 OUs, described in DOE/RL-96-81, Rev. 0, *Waste Site Grouping Report for 200 Areas Soil Investigations*, are located in the 200 East and 200 West Areas and in the surrounding 600 Area. The 200-IS-1 OU was initially defined to contain the waste sites identified in the Waste Information Data System (WIDS) associated with the transfer of high-activity liquid wastes between separations plants and tank farms. The OU was comprised of diversion boxes, catch tanks, and unplanned releases associated with high-activity pipelines located outside the tank farm OUs. Since then, other sites have been added to the 200-IS-1 OU, and the work plan has been revised to address all waste-carrying pipelines, diversion boxes, catch tanks, valve pits, and related structures outside the tank farm OUs. Currently, the majority of the pipelines are not identified in the WIDS database; however, mapping activities are under way to delineate the pipelines and integrate them into WIDS as waste sites. The results of this work plan will be extended to pipelines associated with waste sites in other OUs, waste management areas (WMAs), and zone-based closures. Five RCRA TSD tanks are included in the 200-IS-1 OU and will be characterized through this work plan. These TSD units include: the

CX tank system (tanks 241-CX-70, 241-CX-71, and 241-CX-72) and the Hexone Storage and Treatment Facility (HSTF), (tanks 276-S-141 and 276-S-142).

The 200-ST-1 Septic Tanks and Drain Fields Waste Group OU consists of active and inactive septic systems that received shower water, kitchen wastewater, janitorial sink wastewater, human sewage, and similar liquid waste. Each site typically consists of a large-capacity holding tank that overflows to a gravel-filled drain field. Occupied buildings have a dedicated septic tank/ drain field or share a system with adjacent structures. Sites in this OU served facilities where radiological contamination of the waste stream was considered to be possible. The volume and inventory of waste discharged to these sites were usually not tracked.

Major milestones in the *Hanford Federal Facility and Consent Order* (Tri-Party Agreement) (Ecology et al. 2003a) applicable to the 200-IS-1 and 200-ST-1 OU RI/FS work plan are as follows:

- M-013-00M: Submit one 200 Area RI/FS (RFI/CMS) work plan for the 200-IS-1, Tanks/Lines/Pits Diversion Boxes OU (which includes waste sites in the 200-ST-1 Septic Tank and Drain Fields OU) by December 31, 2002. (Note: This milestone has been completed.)

- M-020-00B: Submit closure/post-closure plans for 216-A-10, 216-A-36B, 216-A-37-1, 207-A south retention basin, 216-S-10 pond, 216-S-10 ditch, 241-CX-70, 241-CX-71, and 241-CX-72 by December 31, 2008.

- M-20-54: Submit 241-CX-70 storage tank, 241-CX-71 neutralization tank, 241-CX-72 storage tank closure/post-closure plan to the Washington State Department of Ecology (Ecology) in coordination with the 200-IS-1 Tanks/Lines/Pits/Boxes and 200-ST-1 Septic Tank OUs work plan FS scheduled under Milestone M-13-00M by December 31, 2008.

- M-15-00C: Complete all 200 Area non-tank farm OU pre-Record of Decision (ROD) site investigations under approved work plan schedules by December 31, 2008.

Revision 0 (DOE/RL-2002-14) of this work plan was submitted to Ecology in May 2003; however, Ecology did not approve the document. A letter was issued by Ecology to the

U.S. Department of Energy (DOE) in August 2003, directing that the work plan include appropriate DOE Office of River Protection (ORP)-owned 200-IS-1 OU wastes sites with the DOE Richland Operations Office (RL)-owned waste sites already incorporated in Rev. 0 of the work plan. The letter and additional discussions also requested that a more in-depth review of potential remedial technologies for pipelines be identified, and an assessment of the use of the observational approach be conducted. A second data quality objective (DQO) process was conducted in 2004 in association with modifications to this work plan after receipt of Ecology's letter. This second DQO effort included the following:

- Assessment of all ORP-owned 200-IS-1 OU waste sites to develop both an integrated technical and a regulatory approach.
- Review of the 200 Areas contaminants of potential concern to establish a contaminant of concern (COC) list applicable to all 200-IS-1 and 200-ST-1 OU waste sites within the Central Plateau.
- Development of a sorting (or "binning") process based on waste site physical characteristics and waste stream attributes that will establish a consistent approach for investigative data organization, risk assessments, and preliminary remedial action decisions in the RI/FS efforts.
- Because the 200-IS-1 OU waste sites traverse the entire Central Plateau and are interconnected with several processing facilities, tank farms, and other waste sites, consideration of a zone-based closure approach was used to view and assess these sites as integrated with their connections and not as "stand-alone" entities.

The work plan addresses three waste site types:

- RCRA TSD tanks in the 200-IS-1 OU, specifically the 241-CX-70, 241-CX-71, and 241-CX-72, and the 276-S-141 and 276-S-142 tank systems
- 200-ST-1 OU septic tank and drain field waste sites, including representative waste site 2607-W3

- Remaining 200-IS-1 OU waste sites, consisting of pipelines, diversion boxes, catch tanks and similar structures, which includes RCRA TSD components associated with the single-shell tank (SST) and double-shell tank (DST) systems.

The 200-IS-1 RCRA TSD components and tank systems (241-CX-70, 241-CX-71, and 241-CX-72, and 276-SX-141 and 276-SX-142) will be addressed using the RCRA/CERCLA integration process described in Section 2.4 of the Implementation Plan (DOE/RL-98-28).

For the remaining sites in the 200-IS-1 and 200-ST-1 OUs, several of the streamlining approaches to the CERCLA process that are identified in the Implementation Plan have been considered in this revised work plan. Those streamlining approaches that could be used, with some modifications or tailoring, to meet the requirements for site evaluations and/or for development of the ROD for these OUs, include the following:

1. <u>Analogous site concept</u>: Many waste sites share common disposal histories and site features. Characterizing and evaluating one or several representative waste sites provides sufficient information to identify appropriate remedial actions at all related sites. The analogous site concept is applicable to the 200-ST-1 Septic Tank and Drain Field OU sites.

2. <u>Contingent or alternate remedy</u>: Developed for cases where uncertainty is associated with the preferred remedy. Use of a contingent or alternate remedy would be included in the ROD in the event that post-ROD confirmation sampling indicates that an alternate remedy is more appropriate for the site. Development of a ROD that permits use of contingent or alternate remedies may be applicable to some 200-IS-1 pipelines, diversion boxes, catch tanks, and related waste sites.

3. <u>Plug-in approach</u>: An approach geared toward implementing remedial actions for new sites identified and/or evaluated after a ROD has been issued. The plug-in approach is built into the ROD through the incorporation of criteria that must be met before a new site can "plug into" the selected remedy(s). Use of the plug-in approach may require additional sampling and evaluation to ensure that the criteria are met. This approach may

be applicable to any new waste site identified post-ROD for inclusion in the 200-IS-1 or 200-ST-1 OUs. The plug-in approach could potentially be modified to allow existing waste sites to plug-in to one of several remedies that are designated in the ROD. Confirmation sampling results would be used to substantiate that the waste site could "plug-in" and be remediated by an approved remedy.

4. Focus package: Used for sites with minimal need for remediation, or where a remedial action would follow the path that was already followed at similar waste sites. The focus package provides evaluation, analyses, and documentation demonstrating that remedial alternatives are not required; provides site-specific information to complete the remedy selection process; and supports issuance of a proposed plan and new or modified ROD. No specific focused packages are identified in this work plan, but the approach is retained for future use, as appropriate.

5. Observational approach: Uses real-time data collection associated with excavation activities. Provides the flexibility necessary to adapt to actual site conditions encountered during remedial actions by scaling the level of effort to the conditions encountered. This method of streamlining is considered to be more cost- and time-effective than traditional approaches that require substantial amounts of pre-remediation characterization data. The observation approach is expected to be applicable to the 200-IS-1 pipelines, diversion boxes, and associated waste sites that are identified for removal.

To focus activities toward future remedy selection for the waste sites, this work plan accomplishes the following objectives:

1. Assess, sort, and group waste sites to identify those sites that will proceed through the RI/FS process and those waste sites where other actions (i.e., reclassification or addressed by another OU) are appropriate.

2. Develop a comprehensive set of site profiles, based on common physical characteristics and waste stream attributes, that encompasses the current and anticipated waste sites to be included within the 200-IS-1 OU.

3. As part of site profile development, identify those physical attributes (e.g., construction materials and/or design features) that can be associated with leaking, potentially leaking, and non-leaking pipelines, diversion boxes, catch tanks, and related structures.

4. Identify and describe potential remedies for those pipelines, diversion boxes, and related waste sites that will require a remedial response.

Sixteen site profiles have been developed for pipelines, diversion boxes, catch tanks, and associated structures, based on depth of the feature below ground surface, activity of the waste streams that were handled (low, moderate, or high), and whether available information indicates that the structure is known or suspected to have leaked or has not leaked. In accordance with current knowledge, existing 200-IS-1 waste sites have been "binned," or associated with one or more of the site profiles. In addition, conceptual contaminant distribution models have been developed for the 200-IS-1 and 200-ST-1 OU waste sites that portray potential release characteristics.

The work plan outlines the regulatory pathway to site closeout for existing and newly identified RL and ORP waste sites. This work plan documents that sufficient data currently exist, or will become available in the near future, with which to associate all pipelines, diversion boxes, catch tanks, and related waste sites with one or more of the 16 site profiles that have been developed. Final definition of the site profiles and all supporting waste site data will be presented in the RI report and used in the FS for identification of preferred and alternate remedial actions. Selected remedies will be presented in a single ROD. Additional site evaluation activities will be performed post–ROD to confirm that site conditions are appropriate for implementation of the preferred remedial response or to support application of an alternate remedial action. The regulatory and characterization streamlining approaches discussed above will be used to direct resources toward cleanup and closure of the waste sites.

The work plan is organized into four parts to differentiate discussions pertaining to the specific wastes site groups, investigative approaches, and the regulatory paths to closure.

- Part I: Presents the scope and objectives of the work plan, background data on the Hanford Site's physical setting, key waste-generating processes, waste stream characteristics, and a general description of the waste sites considered in these OUs.

- Part II: Addresses the approach and rationale for process pipelines, diversion boxes, catch tanks, and related waste sites, including those RCRA TSD components within the 200-IS-1 OU that are part of the SST and DST system; describes the characterization and evaluation approach to be used in the RI/FS process; and proposes a schedule to complete all work through issuance of a ROD.

- Part III: Addresses the approach and rationale for the five RCRA TSD units (241-CX-70, 241-CX-71, and 241-CX-72, as well as the 276-SX-141 and 276-SX-142 tanks); describes the characterization and evaluation approach to be used in the RI/FS process; and proposes a schedule to complete all work through issuance of a ROD and RCRA Permit modification.

- Part IV: Addresses the approach and rationale for the analogous site approach to 200-ST-1 septic tank and drain field sites, describes the characterization and evaluation approach to be used in the RI/FS process, and proposes a schedule to complete all work through issuance of a ROD.

An important element of this work plan is the use of applicable existing and to-be-acquired characterization data from other Hanford waste sites. Integration and presentation of these data in the RI will support selection of remedial alternatives for the 200-IS-1 OU, specifically pipelines, diversion boxes, catch tanks, and associated waste sites.

Characterization data acquired through implementation of the sampling and analysis plan (SAP) (Appendix B) will be used for assessment of the 241-CX-70, 241-CX-71, and 241-CX-72, as well as the 276-S-141 and 276-S-142 RCRA TSD tank system units and the 200-ST-1 OU septic system waste sites. Representative site characterization activities described in the SAP for the 200-ST-1 septic system waste sites are based on implementing the DQO process documented in CP-13196, *Remedial Investigation Data Quality Objectives Summary Report for the 200-IS-1 and 200-ST-1 Operable Units*. The sampling and analysis activities will provide data to refine the conceptual contaminant distribution models, support an assessment of risk, and evaluate a range of remedial alternatives.

The sample collection methods described in the SAP include driven soil probes, borehole drilling, geophysical logging, and soil and soil gas sampling. Analyses will be performed for radiological and nonradiological COCs and selected physical properties. Sampling results will be used to assess the integrity of the tanks at the CX tank system and the 276-S HSTF, and also to determine the nature and extent of contamination at the 2607-W3 septic tank. Based on the results of an initial investigation, additional soil borings or test pits may be required. Sampling for waste designation is addressed through a waste designation DQO process before the field characterization activities are initiated.

CONTENTS

PART II – PIPELINES, DIVERSION BOXES, AND ASSOCIATED WASTE SITES

APPENDICES

LIST OF PLATE MAPS

FIGURES

TABLES

TERMS

ANN	aluminum nitrate nanohydrate
ARAR	applicable or relevant and appropriate requirement
BCG	below concentration guideline
bgs	below ground surface
CAS	Chemical Abstract Service
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
CHG	CH2M Hill Hanford Group, Inc.
COC	contaminant of concern
COPC	contaminant of potential concern
CPP	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980* past-practice
CPT	cone penetrometer technology
DBBP	dibuty butyl phosphonate
DOE	U.S. Department of Energy
dpm	disintegrations per minute
DQA	data quality assessment
DQO	data quality objectives
DST	double-shell tank
Ecology	Washington State Department of Ecology
EE/CA	engineering evaluation/cost analysis
EHQ	environmental hazard quotient
EMI	electromagnetic induction
EPA	U.S. Environmental Protection Agency
FM	frequency module
FY	fiscal year
GG/PN	gross gamma and passive neutron
GPR	ground-penetrating radar
HAB	Hanford Advisory Board
HASP	health and safety plan
HEIS	Hanford Environmental Information System
HPGe	high-purity germanium
HSTF	Hexone Storage and Treatment Facility
HVAC	heating, ventilation, and air conditioning
IAEA	International Atomic Energy Agency
IDW	investigation-derived waste
ICRP	International Commission on Radiological Protection
IMUST	inactive miscellaneous underground storage tank
ITS	in-tank solidification
IX	ion exchange
K_d	distribution coefficient
LERF	Liquid Effluent Disposal Facility

LFI	limited field investigation
LLWMA	low-level waste management area
MIBK	methyl isobutyl ketone
NAVD88	*North American Vertical Datum of 1988*
NEPA	*National Environmental Protection Act of 1976*
NPH	normal paraffin hydrocarbon
O&M	operations and maintenance
ORP	U.S. Department of Energy, Office of River Protection
OU	operable unit
ppb	parts per billion
ppm	parts per million
PFP	Plutonium Finishing Plant
PIF	Plutonium Isolation Facility
PRF	Plutonium Reclamation Facility
PRG	preliminary remediation goal
PUREX	plutonium-uranium extraction
RAO	remedial action objective
RCRA	*Resource Conservation and Recovery Act of 1976*
RDR/RAWP	remedial design report/remedial action work plan
RECUPLEX	Recovery of Uranium and Plutonium by Extraction
REDOX	reduction-oxidation
RESRAD	RESidual RADioactivity (dose model)
RFI/CMS	*Resource Conservation and Recovery Act of 1976* facility investigation/ corrective measures study
RG	rubber glove
RI/FS	remedial investigation/feasibility study
RL	U.S. Department of Energy, Richland Operations Office
RMA	remote mechanical "A"
RMB	remote mechanical "B"
RMC	remote mechanical "C"
ROD	Record of Decision
RPP	*Resource Conservation and Recovery Act of 1976* past-practice
SAP	sampling and analysis plan
SGL	spectral gamma logging
SST	single-shell tank
STOMP	Subsurface Transport Over Multiple Phases
TBP	tributyl phosphate
Tri-Party Agreement	*Hanford Federal Facility Agreement and Consent Order*
TRU	transuranic
TSD	treatment, storage, and disposal
UNH	uranyl nitrate hexahydrate
UO_3	uranium trioxide
UPR	unplanned release
URM	underground radioactive material
URP	uranium recovery process

VCP	vitrified clay pipeline
WAC	*Washington Administrative Code*
WESF	Waste Encapsulation and Storage Facility
WIDS	Waste Information Data System
WMA	waste management area

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METRIC CONVERSION CHART

Into Metric Units			Out of Metric Units		
If You Know	*Multiply By*	*To Get*	*If You Know*	*Multiply By*	*To Get*
Length			**Length**		
inches	25.4	millimeters	millimeters	0.039	inches
inches	2.54	centimeters	centimeters	0.394	inches
feet	0.305	meters	meters	3.281	feet
yards	0.914	meters	meters	1.094	yards
miles	1.609	kilometers	kilometers	0.621	miles
Area			**Area**		
sq. inches	6.452	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.093	sq. meters	sq. meters	10.76	sq. feet
sq. yards	0.836	sq. meters	sq. meters	1.196	sq. yards
sq. miles	2.6	sq. kilometers	sq. kilometers	0.4	sq. miles
acres	0.405	hectares	hectares	2.47	acres
Mass (weight)			**Mass (weight)**		
ounces	28.35	grams	grams	0.035	ounces
pounds	0.454	kilograms	kilograms	2.205	pounds
ton	0.907	metric ton	metric ton	1.102	ton
Volume			**Volume**		
teaspoons	5	milliliters	milliliters	0.033	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.057	quarts
cups	0.24	liters	liters	0.264	gallons
pints	0.47	liters	cubic meters	35.315	cubic feet
quarts	0.95	liters	cubic meters	1.308	cubic yards
gallons	3.8	liters			
cubic feet	0.028	cubic meters			
cubic yards	0.765	cubic meters			
Temperature			**Temperature**		
Fahrenheit	subtract 32, then multiply by 5/9	Celsius	Celsius	multiply by 9/5, then add 32	Fahrenheit
Radioactivity			**Radioactivity**		
picocuries	37	millibecquerel	millibecquerels	0.027	picocuries

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PART I –

GENERAL INFORMATION

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PART I – GENERAL INFORMATION

1.0 INTRODUCTION

This work plan supports the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) remedial investigation/feasibility study (RI/FS) activities for the 200-IS-1 Tanks/Lines/Pits/Boxes Waste Group Operable Unit (OU) and the 200-ST-1 Septic Tanks and Drain Fields Group OU. As discussed in the *Hanford Federal Facility Agreement and Consent Order Action Plan* (Ecology et al. 2003b), the RI/FS work plan is prepared to present information on how the RI and FS processes will be conducted and eventually lead to proposed remedies for the waste sites in an OU. This work plan also integrates the *Resource Conservation and Recovery Act of 1976* (RCRA) facility investigation/corrective measures study (RFI/CMS) requirements for these OUs and utilizes the framework established in DOE/RL-98-28, Rev. 0, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program* (hereinafter referred to as the Implementation Plan), which is the implementation plan for integrating the RCRA treatment, storage, and disposal (TSD) unit closure process with the OU CERCLA RI/FS process. The RCRA TSD tanks included in this work plan that require investigation to comply with RCRA closure/post-closure requirements are the CX tank system (tanks 241-CX-70, 241-CX-71, and 241-CX-72) and the Hexone Storage and Treatment Facility (HSTF) (tanks 276-S-141 and 276-S-142). In addition, components of the RCRA TSD units associated with single-shell tank (SST) and double-shell tank (DST) systems that are part of the 200-IS-1 OU have also been included.

The RCRA closure plans for the CX tank system, the SST and DST components, and the revision to DOE/RL-92-40, Rev. 0, *Hexone Storage and Treatment Facility Closure Plan*, will be submitted in conjunction with the FS to be prepared for the 200-IS-1 and 200-ST-1 OUs. The 241-Z treatment and storage tanks RCRA TSD unit is in service supporting the Plutonium Finishing Plant (PFP) Nuclear Materials Stabilization Project and subsequent facility decontamination and decommissioning until 2011 (DOE/RL-96-82, *Hanford Facility Dangerous Waste Closure Plan, 241-Z Treatment and Storage Tanks*) and is, therefore, not included in this work plan.

The process outlined in the work plan follows the CERCLA format with modifications to concurrently satisfy the additional RCRA requirements. Modifications to the M-013 series of *Hanford Federal Facility Agreement and Consent Order* (Tri-Party Agreement) (Ecology et al. 2003a) milestones for non-tank farm past-practice waste site investigations approved in June 2002 (Tri-Party Agreement Change Number M-13-02-01) included an approach to investigate similar OUs in a single RI/FS process. This milestone modification reduced the number of non-tank farm work plans, RI reports, and FSs. The revised approach allows for collection of the data necessary to adequately characterize the waste sites in more than one OU to support the evaluation of effective remedial alternatives. The scope of this work plan, therefore, addresses waste sites in both the 200-IS-1 and 200-ST-1 OUs.

The 200-IS-1 OU is described in DOE/RL-96-81, Rev. 0, *Waste Site Grouping Report for 200 Areas Soil Investigations*. This OU consists of an extensive network of pipelines, diversion boxes, catch tanks, valve pits, related infrastructure and unplanned releases (UPRs) not assigned to other OUs. The infrastructure was used to transport process waste from separations facilities to SSTs and DSTs and to route low- and medium-activity waste streams to their respective pond and crib waste sites. The characterization and remediation strategies presented in the work plan can be extended to pipelines and related structures associated with other OUs, and used during zone-based area closures. Five RCRA TSD tanks, as well as the RCRA SST and DST components outside the waste management areas (WMAs), will be remediated through this work plan using an integrated RCRA/CERCLA regulatory process.

The 200-ST-1 Septic Tanks and Drain Fields Waste Group OU consists of inactive septic systems that received shower water, kitchen wastewater, janitorial sink wastewater, human sewage, and similar liquid waste. Each site typically consists of a large-capacity holding tank that overflows to a gravel-filled drain field. Occupied buildings have a dedicated septic tank/ drain field or share a system with adjacent structures. Sites in this OU served facilities where radiological contamination of the waste stream was considered to be possible. The volume and inventory of wastes discharged to these sites were usually not tracked.

The original set of waste sites assigned to the 200-IS-1 and 200-ST-1 OUs in the Implementation Plan (DOE/RL-98-28) has been revised through the addition of new waste sites and reclassification of accepted waste sites, in accordance with RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)." Five RCRA TSD tanks within the 200-IS-1 OU are identified as interim status units under *Washington Administrative Code* (WAC) 173-303. These tanks are identified in two Hanford RCRA Dangerous Waste Permit Application, Part A, Form 3's; three tanks in the 241-CX tank systems, Part A, Form 3; and two tanks in the HSTF, Part A, Form 3. In addition, there are SST and DST components occurring outside the WMAs that are considered ancillary equipment and, as such, are associated with the SST and DST Dangerous Waste Permit Application, Part A, Form 3's. The 200-IS-1 waste sites that are included in the aforementioned Dangerous Waste Permit Application, Part A, Form 3's, are listed in Appendix A. The remaining waste sites in the 200-IS-1 and 200-ST-1 OUs are RCRA past-practice (RPP) sites.

The WIDS database identifies 95 waste sites as belonging to the 200-IS-1 OU. These sites consist of pipelines, diversion boxes, and catch tanks known or suspected to be contaminated. Also included is a group of UPR waste sites that represent the leaks and releases from the structures that have contaminated the surrounding soil.

Most pipelines and associated structures in the 200 Areas that potentially could be considered as 200-IS-1 OU waste sites are currently not included in this OU. Under the direction of the U.S. Department of Energy (DOE), Richland Operations Office (RL) and DOE Office of River Protection (ORP), several programs and technical groups are reviewing available engineering drawings and documents to create comprehensive maps delineating the locations of the pipelines and related structures. This activity will continue during the work plan and RI efforts, with new waste sites identified and added through the CERCLA process. Mapping of pipelines outside of but associated with ORP WMAs may continue beyond the issuance of a Record of Decision (ROD).

An initial data quality objectives (DQO) process for the consolidated 200-IS-1 and 200-ST-1 OUs was conducted in the spring of 2002. Rev. 0 (DOE/RL-2002-14) of this work plan was submitted to the Washington State Department of Ecology (Ecology) in May 2003; however, Ecology did not approve the document. A letter was issued by Ecology to DOE in August 2003

(*Tanks/Lines/Pits/Boxes/Septic Tank and Drain Field Waste Group Operable Units Remedial Investigation/Feasibility Study Work Plan and RCRA TSD Unit Sampling Plan, DOE/RL-2002-14, Revision 0* [Price 2003]), directing DOE to include appropriate ORP-owned 200-IS-1 OU wastes sites with the RL-owned waste sites already in Rev. 0 of the work plan. During the fall of 2004, a second DQO process was completed in which ORP and RL developed an integrated RCRA/CERCLA regulatory and technical strategy that would address both ORP- and RL-owned waste sites in the 200-IS-1 OU. This work plan revision satisfies Ecology's requirement for inclusion of the ORP-owned 200-IS-1 OU waste sites.

The data generated through investigations associated with the 200-IS-1 OU will support activities in other core projects in the RL and ORP offices. Integration of the data collection activities with other projects on the Hanford Site will result in more efficient and consistent remediation processes.

The characterization and remediation of waste sites at the Hanford Site are addressed in the Tri-Party Agreement. The schedule of work at the Hanford Site is governed by Tri-Party Agreement milestones. Major milestones applicable for preparing the 200-IS-1 and 200-ST-1 OU RI/FS work plan are as follows:

- M-013-00M: Submit one 200 Areas RI/FS (RFI/CMS) work plan for the 200-IS-1, Tanks/Lines/Pits Diversion Boxes OU (includes waste sites in the 200-ST-1 Septic Tank and Drain Fields OU) by December 31, 2002. (Note: This milestone has been completed.)
- M-020-00B: Submit closure/post-closure plans for 216-A-10, 216-A-36B, 216-A-37-1, 207-A south retention basin, 216-S-10 pond, 216-S-10 ditch, 241-CX-70, 241-CX-71, and 241-CX-72 by December 31, 2008.
- M-20-54: Submit 241-CX-70 storage tank, 241-CX-71 neutralization tank, 241-CX-72 storage tank closure/post-closure plan to Ecology in coordination with the 200-IS-1 Tanks/Lines/Pits/Boxes and 200-ST-1 Septic Tank OUs work plan FS scheduled under M-13-00M by December 31, 2008.
- M-15-00C: Complete all 200 Area non-tank farm OU pre-ROD site investigations under approved work plan schedules by December 31, 2008.

1.1 200 AREAS IMPLEMENTATION PLAN

The Implementation Plan (DOE/RL-98-28) outlines a strategy that streamlines the characterization and remediation of waste sites in the 200 Areas, including CERCLA past-practice (CPP) sites, RPP sites, and certain RCRA TSD units. The plan describes the framework for implementing assessment activities and evaluating remedial alternatives in the 200 Areas and ensures consistency in documentation, level of characterization, and decision making.
A regulatory framework, established and approved by the Tri-Party Agreement, is included in DOE/RL-98-28 to integrate the requirements of RCRA and CERCLA into one standard approach for cleanup activities in the 200 Areas. This approach is illustrated in Figure 1-1. The 200-IS-1 OU includes RCRA TSD and RPP waste sites, and the 200-ST-1 consists only of RPP waste sites. Under the Tri-Party Agreement, Ecology is the lead regulatory agency for both OUs.

The Implementation Plan describes several streamlining approaches to the CERCLA process. These approaches could be applied with some modifications or tailoring to meet requirements for characterization and/or for development of the ROD for these OUs. The streamlining approaches that have been considered during development of this work plan include the following:

1. Analogous site concept: Many waste sites share common disposal histories and site features. Characterizing and evaluating one or several representative waste sites provides sufficient information to plan remedial actions at all related sites. The analogous site approach is applicable to the 200-ST-1 OU septic tank and drain field sites.

2. Contingent or alternate remedy: Developed for cases where there is uncertainty associated with the preferred remedy. Use of a contingent or alternate remedy would be included in the ROD for those cases where post-ROD confirmation sampling indicates that an alternate remedy is more appropriate for the site. Development of a ROD that permits use of contingent or alternate remedies may be applicable to some 200-IS-1 pipelines, diversion boxes, catch tanks, and associated waste sites. A preferred remedy identified for a waste site would be revised if confirmation sampling results indicate that final site characterization data do not support implementation of the selected remedy. An alternate, contingent remedy, more appropriate for the given site conditions, would be used to complete the remedial action.

3. Plug-in approach: An approach geared for new sites identified and/or evaluated after a ROD has been issued. The "plug-in" approach is built into the ROD through the incorporation of criteria that must be met before a new site can "plug into" to the selected remedy(s). Use of the plug-in approach may require additional sampling and evaluation to ensure that the characteristics of a newly identified waste site match the site profile designated for the proposed remedy. It is anticipated that additional waste sites will be identified after the ROD for the 200-IS-1 pipelines, diversion boxes, catch tanks, and related sites has been approved. Ongoing mapping of underground infrastructure, as well as decontamination and decommissioning of facilities, will most likely result in the identification of new waste sites. A plug-in approach for the ROD could potentially also be developed that allows existing waste sites to plug into one or several remedies. Confirmation sampling results would be used to substantiate that the attributes of the site fall within a profile that is matched to a preferred remedy.

4. Focus package: Used for sites where there is minimal need for remediation, or where a remedial action would follow a path similar to that already followed at similar waste sites. The focus package provides evaluation, analysis, and documentation demonstrating that remedial alternatives are not required; provides site-specific information to complete the remedy selection process; and supports issuance of a proposed plan and new or modified ROD. No specific application has been identified for the 200-IS-1 or 200-ST-1 OUs at this time, but this approach will be retained for consideration of future use, as appropriate.

5. Observational approach: Uses real-time data collection associated with excavation activities. Provides the flexibility necessary to adapt to actual site conditions encountered during remedial actions, by scaling the level of effort to the conditions encountered. This method of streamlining is considered to be more cost- and time-effective than traditional and previous Hanford approaches that require substantial amounts of pre-remediation

characterization data. The observational approach would be used for those 200-IS-1 OU waste sites where the preferred remedial alternative is removal.

A significant amount of physical attribute and characterization data related to pipelines, diversion boxes, and associated waste sites is available from other Hanford OUs and programs, as well as from other DOE sites. Compilation of this data will be sufficient to identify appropriate remedial response alternatives. The tanks that are part of 241-CX-70, 241-CX-71, 241-CX-72, 276-SX-141 and 276-SX-142 will require site-specific characterization and evaluation prior to evaluating the alternatives for RCRA TSD closure. Additional discussion concerning the characterization and the remedy selection processes for both the CERCLA waste sites and the RCRA TSD units within the Hanford 200 Areas is presented in Section 2.4 of the Implementation Plan.

For the 200-ST-1 OU waste sites, insufficient data are available to choose preliminary remedial actions; thus, the analogous site concept discussed in the Implementation Plan can be effectively applied to this OU. Waste sites within this OU share common features and have disposal histories that are generally expected with septic systems. Using the analogous site concept, a comprehensive field investigation is conducted at a representative site. Characterization data are used to identify applicable remedies for all analogous waste sites. A focused confirmatory field investigation will then be conducted at the analogous waste sites, as needed, to determine the presence or absence of contaminants and support the appropriateness of the selected remedy.

For the 200-IS-1 OU, significant variability in structural characteristics, concentration/activity of the handled waste streams, potential for leakage, and impact to surrounding soils are associated with the pipelines, diversion boxes, and associated waste sites. Because of these variations, a remedial action that is appropriate for one site may not apply to another. Implementing the appropriate remedy for a waste site could be achieved through development of a ROD with a flexible structure that permitted use of "plug-in" and/or contingent remedy approaches. The format of the ROD will be important, because it is anticipated that additional buried process waste transfer structures will be mapped or discovered as the Central Plateau proceeds through closure. Remedial alternatives identified for the 200-IS-1 OU waste sites may also be appropriate for similar wastes site currently identified in other OUs.

The Implementation Plan lists preliminary, potential applicable or relevant and appropriate requirements (ARARs), and preliminary remedial action objectives (RAOs), and also addresses potentially feasible remedial technologies that may be employed in the 200 Areas. This work plan references the Implementation Plan for further details on several topics, such as general information on the physical setting and the operational history of 200 Area facilities, post-work plan activities, and potential remedial actions and objectives. Refinement of ARARs, RAOs, and technologies will be conducted in the FS.

The discussion presented in Section 1.2 provides additional detail on the structure, content, and objectives of the work plan.

1.2 SCOPE AND OBJECTIVES

This work plan presents background information, existing contaminant distribution data, and the approach that will be used to make remedial decisions for the waste sites. The preliminary remedial action alternatives that are likely to be evaluated in the FS for these waste sites also are identified.

The work plan addresses three key waste site types:

- RCRA TSD tanks in the 200-IS-1 OU, specifically 241-CX-70, 241-CX-71, and 241-CX-72 and the 276-S-141 and 276-S-142 tank systems
- 200-ST-1 OU septic tank and drain field waste sites, including the 2607-W3 representative waste site
- Remaining 200-IS-1 OU waste sites, which consist of pipelines, diversion boxes, catch tanks, and associated structures.

This work plan also contains the sampling and analysis plan (SAP) (Appendix B) for characterization of 241-CX-70, 241-CX-71, and 241-CX-72 and the 276-S-141 and 276-S-142 RCRA TSD tank system units in 200-IS-1, as well as the 2607-W3 representative septic system waste site for the 200-ST-1 OU. Waste management will be conducted under a waste control plan to be prepared before field activities begin.

The initial DQO process conducted in 2002 for the OUs defined the radiological and nonradiological constituents to be characterized and specified the number, type, and location of samples to be collected at the RCRA TSD tank system units within the 200-IS-1 OU, as well as the representative waste site identified for the septic system waste sites comprising the 200-ST-1 OU. The results of the DQO process form the basis for a portion of the work plan and associated SAP (Appendix B). The SAP includes a quality assurance project plan and a field sampling plan for implementing the characterization activities in the field.

A second DQO process was conducted in 2004, after receipt of Ecology's letter requesting inclusion of the ORP-owned waste sites in a revised work plan. Although this process was not officially documented with a formal DQO summary report, the assumptions made and conclusions generated throughout the process form the framework of this revised work plan. A meeting was held with Ecology on November 1, 2004, and a presentation was given outlining the revised work plan approach and content.

The second DQO effort included the following activities:

- Assessment of all ORP-owned 200-IS-1 OU waste sites to develop both an integrated technical and regulatory approach
- Review of all 200 Area contaminants of potential concern (COPCs) to establish a contaminant of concern (COC) list applicable to all 200-IS-1 and 200-ST-1 OU waste sites within the Central Plateau
- Development of a waste site sorting (or "binning") process, based on physical characteristics and waste stream attributes, that can be used to establish a consistent approach for investigative data organization, risk assessments, and preliminary remedial action decisions in the RI/FS effort
- Because the 200-IS-1 OU waste sites traverse the entire Central Plateau and are interconnected with several processing facilities, tank farms, and other waste sites, use a zone-based approach to view and assess these sites as integrated with their various connections and not as "stand-alone" entities.

The use of existing and to-be-acquired site data from other OUs and/or projects is an important strategic element of this work plan. Integration of these data during the RI process will support selection of remedial alternatives for the 200-IS-1 OU waste sites, specifically pipelines, diversion boxes, catch tanks, and associated structures. Characterization data acquired through implementation of the SAP will be used for assessment of the 241-CX-70, 241-CX-71, and 241-CX-72, and the 276-S-141 and 276-S-142 RCRA TSD tank system units and the 200-ST-1 OU septic system waste sites.

Information presented in the RI report will support the evaluation of remedial alternatives and closure options that will be included in the FS and RCRA TSD unit closure plan. Characterization results gathered from investigations conducted at similar waste sites in other OUs, inside the WMAs, and at other DOE facilities will be used. The data compilation and subsequent remedial decisions made under the 200-IS-1 and 200-ST-1 OUs RI/FS process will be applied to newly identified waste sites, as appropriate. The results of this work plan will also be extended to similar waste sites in other OUs, WMAs, and zone-based closures. Confirmatory sampling of waste sites included in the 200-IS-1 and 200-ST-1 OUs will be conducted after remedy selection. The results from sampling and other site evaluation techniques will be used to modify contaminant distribution models as needed, to confirm existing structural conditions, and to support the remedial design process.

For the pipelines and related waste sites, this work plan focuses on identifying and gathering the information that will be needed for selection of the preferred remedy(s) at each waste site. Data-gathering activities include reviewing and compiling existing process knowledge information from technical manuals, flow sheets, and engineering drawings. Pertinent site characterization data available from other OUs and tank farm WMA investigations will also be gathered and evaluated. Specific key attributes associated with a structure (e.g., pipelines, diversion boxes, catch tanks, etc.) will be defined and then used to associate existing and new waste sites with one of the site profiles presented in the work plan. The work plan defines the site information needed to support association with each site profile. Final definition of the site profiles and the associated waste sites, based on the data compilation effort, will be presented in the RI report. Evaluation of environmental risks, worker health and safety, and remediation costs will be completed as part of the RI report and FS alternative analyses to select the preferred remedies.

To focus activities toward future remedy selection for the waste sites, this work plan accomplishes the following objectives:

1. Assess, sort, and group waste sites to identify those sites that will proceed through the RI/FS process and those waste sites where other actions are appropriate. These site groups include the following:
   - Candidates for reclassification as rejected or no action sites in WIDS
   - Septic systems that are candidates for removal from Appendix C of the Tri-Party Agreement, as they are active or not classified as dangerous waste sites in accordance with WAC 173-303
   - Candidate sites for completion of an RI and remedial response assessment.
2. Develop a comprehensive set of site profiles based on waste site attributes that encompass the current and anticipated waste sites to be included within the 200-IS-1 OU. Identification of additional waste sites that will be included in the 200-IS-1 OU is not complete. Ongoing data gathering is being conducted to map underground piping and diversion boxes in the Central Plateau area (outside the tank farm WMAs). Waste site

codes will be assigned to newly identified sites in accordance with Tri-Party Agreement TPA MP-14 procedures (RL-TPA-90-0001) and placed in the WIDS database. WIDS serves as the data management tool listing current OU waste sites and providing site-specific information.

3 As part of site profile development, identify attributes, including material composition and construction, which are associated with leaking, potentially leaking, and non-leaking pipelines, diversion boxes, catch tanks, and related structures. Release mechanisms and contaminant exposures pathways are included in the evaluation.

4 Identify and describe potential remedies for those waste sites requiring a remedial response. Matching of site profiles to remedial responses will be conducted in the FS.

The approach taken in this work plan limits data gathering to the information needed to identify the appropriate remedy for each waste site. Following completion of environmental and human health risk assessments, worker health and safety evaluations, and remediation cost analyses, both preferred and alternate remedies will be identified for each site profile. Following issuance of the ROD, a prescribed focused investigation would be conducted at waste sites to confirm the site profile. The remedy identified for the site profile could then be implemented, and the site would proceed through the closure process.

1.2.1 Work Plan Structure

A number of differences exist in specific regulatory requirements, characterization approaches, and remedial action strategies for the different waste site groups. This work plan is organized into Parts I, II, III, and IV to differentiate discussions pertaining to the specific wastes site groups, investigative approaches, and the regulatory paths to closure. The work plan includes two OUs and several types of waste sites regulated by either RCRA (i.e., TSD units and ancillary equipment) or CERCLA (i.e., RPP sites investigated and closed under the CERCLA process in accordance with the Tri-Party Agreement). Division of the work plan into parts aids in the review process and allows for modifications to the work plan strategy, if needed, to address specific waste sites and/or RCRA or CERCLA regulatory issues. Elements of the work plan include the following:

- Part I: Presents background data on the Hanford Site's physical setting (Section 2.1) and provides a discussion of key waste-generating processes, waste stream characteristics, and general descriptions of waste sites (Section 2.2). Additional information concerning the waste sites is presented in Section 3.0, including known and suspected contaminants, environmental monitoring, nature and extent of contamination, potential impacts to human health and the environment, and the development and listing of COCs.
- Part II: Addresses the approach and rationale for process pipelines, diversion boxes, and related waste sites; describes the characterization and evaluation approach to be used in the RI/FS process; and proposes a schedule to complete all work through issuance of a ROD.
- Part III: Addresses the approach and rationale for the five RCRA TSD units (241-CX-70, 241-CX-71, and 241-CX-72, as well as 276-SX-141 and 276-SX-142 tanks), describes the characterization and evaluation approach to be used in the RI/FS process, and proposes a schedule to complete all work through issuance of a ROD.

- Part IV: Addresses the approach and rational for the analogous site approach to 200-ST-1 septic tank and drain field sites, describes the characterization and evaluation approach to be used in the RI/FS process, and proposes a schedule to complete all work through issuance of a ROD.

Supporting information is included in the following appendices:

- Appendix A: Contains a list of the 200-IS-1 OU waste sites included in the Hanford RCRA Part A Permit Application.
- Appendix B: Contains the SAP.
- Appendix C: Reviews the 200-IS-1 process pipelines, diversion boxes, and associated waste sites.
- Appendix D: Reviews the 200-IS-1 RCRA TSD units.
- Appendix E: Reviews the 200-ST-1 septic tank and drain fields waste sites.
- Appendix F: Provides attribute and site profile summaries for the pipelines, diversion boxes, catch tanks, and associated waste sites.
- Appendix G: Includes a summary of additional characterization data for the pipelines, diversion boxes, and associated waste sites.
- Appendix H: Provides the 200 Area master COPC list and exclusions.
- Appendix I: Provides the preliminary identification of remedial alternatives.

1.3 CHANGE CONTROL

Following approval of this work plan, the major elements (RI/FS steps) of the work plan are requirements that are not expected to change; therefore, the work plan should not change. Specific workscope elements might require modification or refinement as the work progresses. Changes that do not affect the overall intent of the approved work plan or schedule can be made using a change notice. Alternatively, and if agreed to by RL and the lead regulatory agency, unit managers' meetings or predecessor primary documents requiring RL and lead regulatory agency approval also can be used to document changes (e.g., the RI report can be used to document refinements to or focus the FS). Changes to the project schedule that affect assigned M-15 interim milestones will require approval through the Tri-Party Agreement change control process.

Figure 1-1. Integrated Regulatory Process for CERCLA, RCRA Past-Practice, and RCRA TSD Unit Closure.

RI/FS Work Plan and TSD Unit Sampling Plan

- Provides group and site - specific background information on waste sites.
- Defines site characterization needs for representative sites and TSD units based on DQOs to assess nature, extent and rate of release of contamination.
- Includes Sampling and Analysis Plan.
- Addresses both RCRA past practice and RCRA TSD sites.
- Provides pre-ROD schedule.
- Includes the following sections of the RCRA TSD Closure Plan:
  - Section 2, "Facility Description and Location Information"
  - Section 3, "Process Information"
  - Section 4, "Waste Characteristics"
  - Section 5, "Groundwater Monitoring".

RI Report, Including TSD Characterization

- Field Investigation Report for both past - practice and RCRA past - practice and TSD sites.
- Risk assessment may be performed at this stage.

FS and Closure Plans

- Evaluates remediation alternatives/closure options for RCRA past - practice and TSD sites.
- Includes the following sections of the RCRA TSD Closure Plan:
  - Section 6, "Closure Strategy and Performance Standards"
  - Section 7.0 "Closure Activities" and initial Section 8.0 "Post Closure Plan" covered with details deferred to O&M Plan/ Revised Post Closure Plan.
- Identified preferred alternatives(s):
  - Provides consistent remediation/closure strategy for both past practice and RCRA TSD

    200-IS-1 and 200-ST-1 OUs
- RCRA TSD closure plan may be appended to FS as shown or issued separately.

Proposed Plan and Proposed RCRA Permit Modification

- Proposes selected remedy for RCRA past-practice sites based on FS.
- Incorporates proposed RCRA TSD permit conditions consistent with closure plan.
- Public review required:
  - Supporting Closure Plan and FS will be available through Administrative Record for public review.

Public Input (45 days)

RCRA Permit Modification

- Decision document authorizing selected closure strategy for TSDs in Sitewide Permit.
- Reference Proposed Plan/ ROD.
- Administrative change to list RPPs to be addressed per the ROD.

Record of Decision (ROD)

- Decision document authorizing selected remedy for RCRA sites.

Remedial Design/ Remedial Action Work Plan

- Designs and implements chosen remedy/closure strategy for RCRA TSDs
- Details closure activities for TSD including:
  - Closure sampling and monitoring
  - Final cover design for closure as a landfill.
- Includes Sampling and Analysis Plan for confirmation and verification sampling.
- Provides post - ROD schedule following CERCLA schedule.

2.0 BACKGROUND AND SETTING

This section describes waste site information and the hydrogeologic conditions associated with the 200-IS-1 and 200-ST-1 OUs. The information presented in this section addresses the physical setting, waste site description, history, and waste-generating processes for the 241-CX-70, 241-CX-71, and 241-CX-72, and 276-S-141 and 276-S-142 RCRA TSD tank system units (RCRA TSD units); the 200-ST-1 OU representative site (2607-W3); and the remaining 200-IS-1 OU waste sites. Section 2.2.3 provides a brief summary the RCRA TSD units, 2607-3W, and pipeline/diversion box sites. Additional summary information is provided in Appendix C for other 200-IS-1 and 200-ST-1 OU waste sites that will not be immediately characterized but will be addressed in future planning efforts. Information in this section has been compiled from a number of sources, the most significant of which are as follows:

- CP-13196, *Remedial Investigation Data Quality Objectives Summary Report for the 200-IS-1 and 200-ST-1 Operable Units*
- DOE/RL-98-28, Rev. 0, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*
- DOE/RL-95-13, Rev. 0, *Limited Field Investigation for the 200-UP-2 Operable Unit*
- BHI-00033, Rev. 0, *Surface and Near-Surface Field Investigation Data Summary Report for the 200-UP-2 Operable Unit*
- DOE/RL-96-81, Rev. 0, *Waste Site Grouping Report for 200 Areas Soil Investigations*
- DOE/RL-2000-60, Rev. 0, *Uranium-Rich Process Waste Group Operable Unit RI/FS Work Plan and Process Waste RCRA TSD Unit Sampling Plan*
- WMP-18061, Rev. 0, Draft A, *Optimizations Strategy for Central Plateau Closure*
- PNNL-13788, *Hanford Site Groundwater Monitoring for Fiscal Year 2001*
- WIDS
- Hanford engineering drawings.

Certain subsections below contain information that will be used for portions of the FS and closure plan. Section 2.0 (Facility Description and Location Information) and Section 3.0 (Process Information) of the closure plan are discussed in Sections 2.1 and 2.2 of this work plan, respectively. Section 4.0 (Waste Characteristics) and Section 5.0 (Groundwater Monitoring) of the closure plan correspond to information provided in Sections 2.2.3 and 3.4 of this work plan, respectively.

2.1 PHYSICAL SETTING

The following subsections summarize the geology and hydrology associated with the 200 Areas, including the 200-IS-1 and 200-ST-1 OUs. Additional details on the physical setting of the 200 Areas and vicinity are provided in Appendix F of the Implementation Plan (DOE/RL-98-28).

2.1.1 Topography

The 200-IS-1 and 200-ST-1 OUs include waste sites located in both the 200 East and 200 West Areas of the Central Plateau. The Central Plateau (Figure 2-1) is the common reference used to describe the broad, flat area that constitutes a local topographic high in which the 200 Areas are located on the Hanford Site. The plateau was formed approximately 13,000 years ago during the cataclysmic Missoula floods. The northern boundary is defined by an erosional channel that runs east-southeast before turning south just east of the 200 East Area. This erosional channel formed during the waning stages of flooding as the floodwaters drained from the basin. The northern half of the 200 East Area lies within this ancient flood channel. A secondary flood channel running southward off the main channel bisects the 200 West Area. The buried former river and flood channels could provide preferential pathways for groundwater and contaminant movement.

Waste sites in the 200 West Area are situated in a relatively flat area in a secondary flood channel. Surface elevations range from approximately 205 m (673 ft) to 217 m (712 ft) (from the *North American Vertical Datum of 1988* [NAVD88]), and the surface slopes gently to the west. Waste site surface elevations in the 200 East Area and vicinity range from approximately 189 m (620 ft) NAVD88 in the northern portion of the 200 East Area to 230 m (755 ft) at waste sites just south of the 200 East Area. The surface inside the 200 East Area slopes gently to the northeast.

2.1.2 Geology

The 200-IS-1 and 200-ST-1 OUs are underlain by basalt of the Columbia River Basalt Group and a sequence of suprabasalt sediments. From oldest to youngest, major geologic units of interest are the Elephant Mountain Basalt Member, the Ringold Formation, the Cold Creek unit, the Hanford formation/Cold Creek unit, and the Hanford formation. The fluvial-lacustrine Ringold Formation is informally divided into several informal units (from oldest to youngest): Unit A, Lower Mud, Unit E, and Upper Unit. The Ringold Formation is overlain by a Plio-Pleistocene-aged unit in the 200 West Area, consisting of a locally derived subunit that is interpreted to be a weathered surface that developed on the top of the Ringold Formation (WHC-SD-EN-TI-290, Rev. 0, *Geologic Setting of the Low-Level Burial Grounds*; PNL-7336, *Geohydrology of the 218-W-5 Burial Ground, 200-West Area, Hanford Site*) and an eolian facies (Slate 1996). The eolian facies originally was described as a separate unit called the early "Palouse soil." A recently identified unit of questionable origin, referred to as the Hanford formation/Cold Creek unit, is reported in the northeast corner of the 200 East Area. This unit could be equivalent or partially equivalent to the Cold Creek unit, or it may represent the earliest Ice Age flood deposits overlain by a locally thick sequence of fine-grained, non-flood deposits (HNF-5507, Rev. 0A, *Subsurface Condition Report for the B-BX-BY Waste Management Area*). Glaciofluvial cataclysmic flood deposits of the Hanford formation are present in both the 200 East and 200 West Areas. The Hanford formation deposits consist of gravel-dominated and sand-dominated sequences. A generalized stratigraphic column for the 200 East and 200 West Areas is shown in Figure 2-2.

The Elephant Mountain Basalt Member is a medium- to fine-grained tholeiitic basalt with abundant microphenocrysts of plagioclase (DOE/RW-0164-F, *Consultation Draft, Site Characterization Plan, Reference Repository Location, Hanford Site, Washington*). Basalt is overlain by the Ringold Formation over most of the 200 East Area and all of the 200 West Area. This formation consists of an interstratified sequence of unconsolidated clay, silt, sand, and granule to cobble gravel deposited by the ancestral Columbia River. These alluvial sediments consist of four major units (from oldest to youngest): the fluvial gravel and sand of Unit A, the buried soil horizons and lake deposits of the Lower Mud sequence, the fluvial sand and gravel of Unit E, and the lacustrine mud of the Upper Ringold.

Overlying the Ringold Formation in the 200 West Area is the locally derived subunit of the Cold Creek unit, which consists of poorly sorted, locally derived, interbedded reworked loess, silt, sand, and basaltic gravel (WHC-SD-EN-TI-290). The subunit consists of a lower carbonate-rich paleosol (caliche) and an upper eolian facies. The carbonate-rich section consists of interbedded carbonate-poor and carbonate-rich strata. The upper silty eolian facies had been interpreted to be early Pleistocene loess and had been referred to as the early Palouse soil (PNL-7336). Generally, it is well-sorted quartz-rich/basalt-poor silty sand to sandy silt (BHI-00270, Rev. 1, *Pre-Operational Baseline and Site Characterization Report for the Environmental Restoration Disposal Facility*).

Where the Ringold Formation and Cold Creek unit are not present, the Hanford formation/Cold Creek unit and Hanford formation sediments overlie the basalt. The Hanford formation/Cold Creek unit is made up of two facies and has been identified only in the 200 East Area near the B, BX, and BY Tank Farms. The lower facies overlies basalt and is described as loose, unconsolidated sandy gravel to gravelly sand (HNF-5507). These gravels contain 50% to 70% basalt and are similar to and often indistinguishable from Hanford formation flood gravels in the absence of the second facies. The second facies consists of an olive-brown to olive-gray, well-sorted calcareous eolian/overbank silt with laminations, as well as pedogenic structures. However, the second facies also has been observed to be massive and void of any sedimentary or pedogenic structures. The Hanford formation consists of unconsolidated gravel, sand, and silts deposited by cataclysmic floodwaters. These deposits consist of gravel-dominated and sand-dominated facies. The gravel-dominated facies consist of cross-stratified, coarse-grained sands and granule-to boulder-size gravel. The gravel is uncemented and matrix poor. The sand facies consists of well-stratified, fine- to coarse-grained sand and granule gravel. Silt in these facies is variable and might be interbedded with the sand. Where the silt content is low, an open - framework texture is common. An upper and lower gravel unit and a middle sand facies are present in the study area.

Holocene-aged deposits overlie the Hanford formation and are dominated by eolian sheets of sand that form a thin veneer across the Site, except in localized areas where the deposits are absent. Surficial deposits consist of very fine- to medium-grained sand to occasionally silty sand. Silty deposits less than 1 m (approximately 3 ft) thick also have been documented at waste sites where fine-grained, windblown material has settled out through standing water over many years.

2.1.3 Vadose Zone

The vadose zone is approximately 104 m (340 ft) thick in the southern section of the 200 East Area and thins to as little as 0.3 m (1 ft) near West Lake to the north. Sediments in the vadose zone are dominated by the Ringold Formation and the Hanford formation. The Hanford formation/Cold Creek unit contact might be present in a small area immediately above the basalt beneath the B-BX-BY Tank Farms. Because erosion during cataclysmic flooding removed much of the Ringold Formation north of the central part of the 200 East Area, the vadose zone is predominantly composed of Hanford formation sediments between the northern portion of the

200 Areas and Gable Mountain. Areas of basalt also project above the water table north of the 200 East Area.

In the 200 West Area, the vadose zone thickness ranges from 79 m (261 ft) in the southeast corner to 102 m (337 ft) in the northwest corner. Sediments in the vadose zone are the Ringold Formation, the Cold Creek unit, and the Hanford formation. Erosion during cataclysmic flooding removed some of the Ringold Formation and Cold Creek unit.

Perched water historically has been documented above the Cold Creek unit at locations in the 200 West Area. While the liquid waste disposal facilities were operating, many localized areas of saturation or near saturation were created in the soil column. With the reduction of artificial recharge in the 200 Areas, the downward flux of liquid in the vadose zone beneath these waste sites has been decreasing. As unsaturated conditions are reached, the liquid flux at these disposal sites becomes increasingly less significant as a source of recharge and contaminant movement to groundwater. However, the moisture in the vadose zone is expected to remain elevated over pre-operational levels for some time. In the absence of artificial recharge, recharge from natural precipitation becomes the dominant driving force for moving contaminants remaining in the vadose zone to groundwater.

2.1.4 Groundwater

The unconfined aquifer in the 200 Areas occurs within the Hanford formation/Cold Creek unit, the Hanford formation, or the Ringold Formation, depending on the location. Groundwater in the unconfined aquifer flows from recharge areas where the water table is high (west of the Hanford Site) to areas where it is low (e.g., near the Columbia River) (PNNL-13316, *Hanford Site Groundwater Monitoring for Fiscal Year 1999*). In the northern half of the 200 East Area, the water table is present within the Hanford formation, except in areas where basalt extends above the water table. Near the B-BX-BY WMA, the water table occurs within the Hanford formation/Cold Creek unit. In the central and southern sections of the 200 East Area, the water table is located near the contact of the Ringold Formation and Hanford formation.

Depth to the water table in the 200 East Area and vicinity ranges from approximately 54 m (177 ft) near B Pond to over 104 m (340 ft) near the southern section. The water table across the 200 East Area is very flat (Figure 2-3), making it difficult to determine groundwater flow direction based on water-level measurements from monitoring wells. Contaminant-plume geometry, however, indicates that groundwater flows to the northwest in the northern half of the 200 East Area and to the east-southeast in the southern half of the 200 East Area. Identifying the specific location of the groundwater divide between the northern and southern sections is hampered by the flat water table. Highly transmissive Hanford formation sediments cause the flat water table in the 200 East Area. Because surface liquid discharges were terminated in the 200 East Area, the water table has been declining at a rate of about 0.14 m/yr (0.45 ft/yr) based on measurements collected between March and April of 2001 and March 2002 (PNNL-13788).

Groundwater beneath the 200 West Area occurs primarily in the Ringold Formation. Depth to water varies from approximately 50 m (164 ft) to greater than 100 m (328 ft). Groundwater flow is predominately to the east (Figure 2-3). The surface elevation of the water table beneath the 200 West Area is dropping at a rate of approximately 0.35 m/yr (1.1 ft/yr) (PNNL-13788).

Recharge to the unconfined aquifer within the 200 Areas is from natural and, possibly, artificial sources. Any natural recharge originates from precipitation. Estimates of recharge from precipitation range from 0 to 10 cm/yr (0 to 4 in./yr) (PNNL-13788) and depend largely on soil texture and the type and density of vegetation. Artificial recharge occurred when effluent such as cooling water was disposed of to the ground. PNL-5506, *Hanford Site Water Changes – 1950 through 1980, Data Observation and Evaluation*, reports that between 1943 and 1980, 6.33×10^{11} L (1.67×10^{11} gal) of liquid waste were discharged to the soil column. Most sources of artificial recharge have been halted. A small potential exists for intermittent discharges from broken raw water lines before they were discovered and repaired. The artificial recharge that does continue is largely limited to liquid discharges from sanitary sewers, two state-approved land disposal structures, and 140 small-volume, uncontaminated, miscellaneous streams.

2.1.5 Summary of Hydrogeologic Conditions at RCRA TSD Units and the 200-ST-1 OU Representative Site

The following subsections present the lithology, stratigraphy, and general location information about each of RCRA TSD tank units and the representative waste site selected for the 200-ST-1 OU.

2.1.5.1 241-CX Tank System

The 241-CX tank system consists of the 241-CX-70, 241-CX-71, and 241-CX-72 tanks. The tank system is located in the central portion of the 200 East Area, within the Hot Semi-Works Facility stabilized area (200-E-41).

2.1.5.1.1 241-CX-70 Tank. The location of the 241-CX-70 tank is shown on Plate Map 1. The surface elevation at this site is 208.05 m (682.58 ft) NAVD88. Stratigraphic units at this site consist of, in ascending order, basalt of the Elephant Mountain Member, Ringold Formation (Unit A), and the Hanford formation sand-dominated sequence. The Hanford formation and part of Ringold Unit A occur within the vadose zone. The stratigraphy at the 241-CX-70 tank is based on data from wells 299-E27-5 and 299-E24-8 (Figure 2-4). Groundwater beneath the tank occurs within Ringold Unit A, approximately 86.6 m (284 ft) below ground surface (bgs).

2.1.5.1.2 241-CX-71 Tank. The 241-CX-71 tank is shown on Plate Map 1. The surface elevation at this site is 208.08 m (682.67 ft) NAVD88. Stratigraphic units at this site consist of, in ascending order, basalt of the Elephant Mountain Member, Ringold Formation (Unit A), and the Hanford formation sand-dominated sequence. The Hanford formation and part of Ringold Unit A occur within the vadose zone. The stratigraphy at the 241-CX-71 tank is based on data from wells 299-E27-5 and 299-E24-8 (Figure 2-4). Groundwater beneath the tank occurs within Ringold Unit A, approximately 86.6 m (284 ft) bgs.

2.1.5.1.3 241-CX-72 Tank. The 241-CX-72 tank is shown on Plate Map 1. The surface elevation at this site is 208.08 m (682.67 ft) NAVD88. Stratigraphic units at this site consist of, in ascending order, basalt of the Elephant Mountain Member, Ringold Formation (Unit A), and the Hanford formation sand-dominated sequence. The Hanford formation and part of Ringold Unit A occur within the vadose zone. The stratigraphy at the 241-CX-72 tank is based on data from wells 299-E27-5 and 299-E24-8 (Figure 2-4). Groundwater beneath the tank occurs within Ringold Unit A, approximately 86.6 m (284 ft) bgs.

2.1.5.2 Hexone Storage and Treatment Facility

The HSTF is comprised of the 276-S-141 and 276-S-142 tank system. It is located in the southeast corner of the 200 West Area, northwest of the Reduction-Oxidation (REDOX) Canyon and service facility (S Plant), and consists of two 24,000-gal tanks.

2.1.5.2.1 276-S-141 Tank. The location of 276-S-141 tank is shown on Plate Map 2. The surface elevation at this site is approximately 205.4 m (674 ft) NAVD88. Stratigraphic units at this site consist of, in ascending order: basalt of the Elephant Mountain Member; Ringold Unit A, Lower Mud Unit, and Unit E; the undifferentiated Cold Creek unit; and the Hanford formation sand-dominated sequence. Of these units, the Ringold Unit E, the undifferentiated Cold Creek unit, and the Hanford formation are within the vadose zone and are the principal units of interest in this site. The stratigraphy at the 276-S-141 tank is shown in Figure 2-5 and is based on the geology at well 299-W22-14. Groundwater beneath the tank occurs within Ringold Unit E at approximately 70.9 m (232.6 ft) bgs.

2.1.5.2.2 276-S-142 Tank. The location of the 276-S-142 tank is shown on Plate Map 2. The surface elevation at this site is approximately 205.4 m (674 ft) NAVD88. Stratigraphic units at this site consist of, in ascending order: basalt of the Elephant Mountain Member; Ringold Unit A, Lower Mud Unit, and Unit E; the undifferentiated Cold Creek unit; and the Hanford formation sand-dominated sequence. Of these units, Ringold Unit E, the undifferentiated Cold Creek unit, and the Hanford formation are within the vadose zone and are the principal units of interest in this site. The stratigraphy at the 276-S-142 tank is shown in Figure 2-5 and is based on the geology at well 299-W22-14. Groundwater beneath the tank occurs within the Ringold Unit E at approximately 70.9 m (232.6 ft) bgs.

2.1.5.3 200-ST-1 OU Representative Waste Site – 2607-W3 Septic Tank

The 2607-W3 septic tank is located in the northeast portion of the 200 West Area (Plate Map 2). The surface elevation at this site is 217.1 m (712 ft) NAVD88. Stratigraphic units at this site consist of, in ascending order: basalt of the Elephant Mountain Member, Ringold Unit E and Upper Unit, the undifferentiated Cold Creek unit; and the Hanford formation sand- and gravel-dominated sequences. Of these units, the Ringold Unit E, the undifferentiated Cold Creek unit, and the Hanford formation are within the vadose zone and are the principal units of interest in this site. The stratigraphy at the 2607-W3 septic tank is shown in Figure 2-6 and is based on the geology at well 299-W27-13 and 299-W11-19. Groundwater beneath the 2607-W3 septic tank occurs within the Ringold Unit E at approximately 75.3 m (247 ft) bgs.

2.2 WASTE SITE DESCRIPTION AND HISTORY

The waste sites originally assigned to these OUs in DOE/RL-98-28 have been revised over the last several years by adding new waste sites and reclassifying certain waste sites in accordance with TPA-MP-14 procedures (RL-TPA-90-0001). Section 4.1 describes the method used during the DQO process to determine the waste sites that this work plan considers.

The following facilities generated and stored waste streams for the 200-IS-1 and 200-ST-1 OU waste sites:

- B Plant
- T Plant

- U and Uranium Trioxide (UO_3) Plants
- REDOX Plant (S Plant)
- Plutonium-Uranium Extraction (PUREX) Plant (A Plant)
- Z Plant complex
- Hot Semi-Works Facility (C Plant)
- Tank farms, evaporators, and ancillary facilities.

All the 200-IS-1 and 200-ST-1 waste sites are located within the 200 Area industrial (exclusive) land-use boundary, as identified in DOE/EIS-0222-F, *Final Hanford Comprehensive Land-Use Plan Environmental Impact Statement*, and documented in the "Hanford Comprehensive Land-Use Plan Environmental Impact Statement (HCP EIS), Hanford Site, Richland, Washington; Record of Decision" (64 FR 61615). Appendices C, D, and E contain summary information on the waste sites covered by this work plan.

2.2.1 200 Area Plant History

The following discussion summarizes historical process operations at 200 Area facilities that were associated with the 200-IS-1 and 200-ST-1 OU waste sites addressed in this work plan.

2.2.1.1 B Plant

Constructed in 1944, the B Plant complex operated from 1945 to 1952 using the bismuth phosphate/lanthanum fluoride process to recover plutonium. The bismuth phosphate/lanthanum fluoride process steps were conducted in the 221-B Canyon Building as a series of batch-wise, inorganic chemical separation steps that removed plutonium from the dissolved irradiated uranium fuel rods. The lanthanum fluoride process was conducted in the 224-B Facility and further purified the plutonium. The 222-B Laboratory supported operations at the 221-B Building complex and other 200 Area facilities from 1945 to 1952.

Starting in 1952, 221-B Plant was decontaminated and later refitted for waste treatment operations. In 1963, the Waste Fractionization Project began recovering strontium, cerium, and rare earth metals as part of Phase I processing. Phase I processing ended in June 1966 to accommodate Phase II construction, and Phase III waste fractionization processing began in 1968. This process separated the long-lived radionuclides strontium-90 and cesium-137 from high-level/high-activity PUREX and REDOX waste and stored a concentrated solution of strontium-90 and cesium-137 at the 221-B Building. Large quantities of tank wastes were transferred to B Plant for fission product recovery. In 1968, B Plant underwent further renovations, and the Waste Encapsulation and Storage Facility (WESF) was added to concentrate, encapsulate, and store radioactive waste. Waste fractionization and encapsulation efforts continued until 1986 (DOE/RL-92-05, Rev. 0, *B Plant Source Aggregate Area Management Study Report*).

2.2.1.2 T Plant

The T Plant was constructed from 1943 through 1944, and the bismuth phosphate/lanthanum fluoride process was used from 1945 to 1956 to recover plutonium. In 1957, the 221-T Building was converted to a decontamination and equipment refurbishment facility. The facility provided services in radioactive decontamination, reclamation, and decommissioning of process equipment, and it still currently serves the Hanford Site in this capacity. A series of testing programs by Pacific Northwest National Laboratory and Westinghouse Hanford Company also occurred intermittently from 1964 to 1990 (DOE/RL-91-61, Rev. 0, *T Plant Source Aggregate Area Management Study Report*). The 222-T Laboratory supported operations at the 221-T Building from 1945 to 1956. After 1956, all laboratory analyses of T Plant operations were sent to the 222-S Laboratory.

2.2.1.3 U Plant

The U Plant was constructed in 1944 and included the 221-U Canyon Building, the 224-U Building, and the 222-U Laboratory. U Plant's design matched that of the T and B Plants and initially was used to train personnel for the bismuth phosphate operations. For training only, water was used in the plant systems and no waste was generated. In 1951, U Plant was modified for the uranium recovery process (URP), which ran from 1952 to 1958. Uranium metal wastes from the bismuth phosphate process (stored in the SSTs) were transferred to the 221-U Building where a large-scale, solvent-extraction process was used to separate uranium from fission products. The process was the first to use tributyl phosphate (TBP) solvent in a normal paraffin hydrocarbon (NPH) diluent, later applied at the PUREX Facility. The residual high-activity wastes were then returned to the tank farms. In 1953, a "scavenging" step to precipitate strontium-90 and cesium-137 fission products was implemented in the URP operation. Following cessation of the URP, the 221-U Plant also performed equipment decontamination operations similar to those conducted at T Plant before being contaminated in 1966-1967 (DOE/RL-91-52, Rev. 0, *U Plant Source Aggregate Area Management Study Report*).

The final operation of the uranium recovery process was conducted in the 224-U Building. Uranyl nitrate hexahydrate (UNH) was calcined into UO_3 powder and packaged for shipment offsite. The facility also received uranium-bearing solutions from the 202-S REDOX Facility from 1951 until 1967 when that process was stopped. In 1957, the batch operation was updated to a continuous-flow calcining process, and the 224-U Building became known as the UO_3 Plant (DOE/RL-91-52). The UO_3 Plant also received PUREX uranium hexahydrate from 1958 to 1972, when PUREX was placed in "stand-down" mode. The UO_3 Plant resumed operations in 1984 to process UNH following the 1983 restart of the PUREX Plant. The UO_3 Plant operations ceased in 1988 (DOE/RL-2000-60), except for a final 1993 run that processed PUREX waste generated during a 1992 cleanout run.

2.2.1.4 REDOX Plant

The reduction-oxidation (REDOX) process was conducted at the 202-S REDOX Plant (also known as S Plant) and was the first continuous separations process at the Hanford Site that recovered both uranium and plutonium. The process was based on a solvent-extraction technology that used methyl isobutyl ketone (MIBK, or hexone) and aluminum nitrate nonohydrate (ANN) in nitric acid to complete these separations. Plant operations began in 1952 and continued until 1967, when a fire in the plutonium purification column at the 233-S Facility halted operations (DOE/RL-91-60, Rev. 0, *S Plant Aggregate Area Management Study Report*).

The 222-S Laboratory is currently one of the primary waste generators in the REDOX area. The laboratory was constructed from 1950 through 1951 and is located immediately south of the 202-S Building. The laboratory provides high-, moderate-, and low-activity radiological and nonradiological analytical services for operations in the 200 Areas. The laboratory continues to support Hanford operations, with emphasis on waste management, offsite shipment certification, chemical processing, and environmental monitoring programs throughout the 200 West and 200 East Areas (including B Plant, U Plant, the tank farms, the 242-A and 242-S Evaporators, WESF, PUREX Plant, and Z Plant complex operations).

2.2.1.5 PUREX Plant

The plutonium-uranium extraction (PUREX) process was based on the same solvent extraction developed for the URP operation at U Plant. The separation process was conducted at the 202-A PUREX Plant. Started in 1955, it initially complimented and then replaced the REDOX process, operating continuously until 1972. The PUREX process used TBP in NPH and a recoverable salting agent (nitric acid) that proved economically more feasible, generated less waste, and operated more safely than the REDOX process. The PUREX Plant was placed in standby mode from 1972 until it was restarted in 1983, continuing operation until 1988. The internal piping and vessels were flushed out in a series of cleanout runs in 1992, and the facility was then deactivated. The 202-A Laboratory supported PUREX operations at the 202-A Building from 1955 to 1972, and again from 1983 to 1988.

2.2.1.6 Z Plant Complex

The Z Plant complex consists of two main buildings and numerous smaller facilities that were used to isolate and purify plutonium. Other processes produced metallic plutonium and plutonium oxides, milled and machined plutonium oxides and metals, and processed plutonium scrap materials. Various operations and experimental laboratories also supported the many missions of the Z Plant complex. At present, the Z Plant complex is being transitioned from a stabilization mission to deactivation and decommissioning as part of PFP site closure.

The 231-Z Building, also known as the Plutonium Isolation Facility (PIF) or the Concentration Building, was the final step for plutonium extracted in the B and T Plant bismuth phosphate process. It was constructed in 1944 and served to further purify plutonium-product solutions and convert them to a concentrated plutonium/nitrate paste before shipment offsite. With construction and startup of PFP in 1949, the 231-Z Building was converted into a plutonium metallurgy laboratory and operated in this capacity from the 1950s through 1970s. The Atomic Energy Commission's Division of Military Application used the facility between 1960 and 1975 to support testing programs at the Nevada Test Site. Gloveboxes, hoods, and other plutonium-containing equipment were decontaminated between 1978 and 1982. The 231-Z Building is currently in post-operation surveillance and maintenance mode and is awaiting closure.

In 1948, the 234-5 Z Building and ancillary facilities were constructed to replace the isolation process in the 231-Z Building. A series of processes, or lines, were used to reduce plutonium nitrate to a metal or oxide form. The rubber glove (RG) line was initially used to reduce plutonium nitrate to metal and/or oxide forms beginning in 1949, using a batch, inorganic chemical process. The remote mechanical "A" (RMA) line operations replaced the RG operations in 1953 and continued until 1979. The remote mechanical "C" (RMC) line became operational in 1960 and continued until 1989. A remote mechanical "B" (RMB) line was built but never operated. The RMA and RMC used the same chemical process as the RG line; however, the RMA and RMC operations were conducted by operators using remote mechanical devices rather than rubber gloves within gloveboxes and hoods. The PFP was also used to fabricate plutonium metal into weapons shapes from the metal buttons produced in the RMA line operations from 1953 to the 1970s and RMC line operations from 1962 to the early 1990s.

Process lines within the 234-5 Building have been deactivated and the structure is awaiting remediation.

Scrap plutonium was reprocessed at several facilities between 1953 and 1987. The 234-5 Z Building housed the Recovery of Uranium and Plutonium by Extraction (RECUPLEX) process, which used TBP in a carbon tetrachloride diluent. The RECUPLEX process operated from 1953 until a criticality ended operations in 1962. The Plutonium Reclamation Facility (PRF), located in the 236-Z Building, replaced RECUPLEX operations in 1964. The PRF operated until 1987 and recovered plutonium from scrap solutions and materials within the PFP and other DOE facilities using the same basic chemical separations reactions used in the RECUPLEX process.

The 242-Z Building housed the americium recovery process line. The process was used from 1964 to 1976 to recover americium from the PFP process line when ion-exchange (IX) column ceased operations. The 242-Z Building has been deactivated and is awaiting final closure.

The 241-Z Building is located south of the 234-5 Z Building and houses equipment used to temporarily store and treat process effluents from PFP. The facility includes a series of five below-grade tanks set in individual concrete sumps (including four RCRA TSD units: D-4, D-5, D-7, and D-8). Also included are two above-grade tanks used to mix chemical additives.

2.2.1.7 Hot Semi-Works

The Hot Semi-Works Facility (or C Plant) was the main experimental process engineering laboratory for the Hanford Site and was used to test separations processes using high-activity materials. The original site consisted of the 201-C Process Building, support facilities, and the 209-E Critical Mass Laboratory. At present, the 201-C Building has been dismantled to grade and is covered under a 2.4– to 3-m (8- to 10-ft) thickness of fly ash. The 209-E Critical Mass Laboratory, used to test configurations of transuranics (TRUs) to better quantify criticality parameters, is awaiting decontamination.

During its history, the Hot Semi-Works Facility went through three distinct operational phases: (1) pilot-plant testing for the REDOX process, (2) pilot-plant testing for the PUREX process, and (3) pilot-plant testing for the strontium recovery process. The REDOX process studies took place between November 1952, and October 1953. Among other things, these studies evaluated dissolution and feed preparation, solvent-extraction processes, and process scavenging. The 241-CX-70 and 241-CX-71 underground storage tanks were used at this time.

The PUREX process was studied intensively at the Hot Semi-Works Facility between 1954 and 1957. Testing included processing irradiated slugs produced at the Hanford Site to recover plutonium and decontamination products. Among the aspects of the process investigated were process chemistry, properties of chemical solvents at different concentrations, solvent recycling, uranium-processing rates, solvent-extraction column performance, and decontamination deficiencies. The 241-CX-72 tank was used during this timeframe to examine self-concentration of wastes.

Hot Semi-Works studies for the purification of strontium-90 took place between 1961 and 1967. The strontium recovery process was performed via solvent extraction using a complexant, di-2-ethyl-hexyl phosphoric acid (D2EHPA), to extract strontium from acid solutions of waste fuels (HW-72666, *Hot Semi-Works Strontium-90 Recovery Program*). Cerium, technetium, and promethium, as well as minor amounts of americium and curium in the final production run, were also extracted.

2.2.1.8 Tank Farms and Ancillary Facilities

Since 1944, high-level wastes generated by the separations plants have been stored in 149 SSTs and 28 DSTs within the 200 Areas. The 177 tanks are grouped into 12 SST and 6 DST tank farms. All tank farms and most ancillary equipment carry a "241-" prefix to identify their association with high-level/high-activity waste storage. The individual tank farms carry a letter code (A, B, C, S, T, and U), which indicates the original processing plant that the farm received waste from. For remediation purposes, the 18 tank farms are presently grouped into one of seven tank WMAs, which include all facilities and equipment within the respective fence lines.

The 241-B, 241-C, 241-T, and 241-U Tank Farms were initially constructed in 1943 with twelve 530,000-gal capacity, 75-ft diameter, 100-series tanks arranged in four, three-tank cascades. In addition, four 55,000-gal capacity, 20-ft diameter, 200-series tanks were also built into each farm. All tanks are constructed of a single concrete vertical wall, with dished bottoms and curved plates joining the bases to the vertical sides. Four diversion boxes were constructed for each farm to route waste to individual tanks or tank cascades. The 241-BX Tank Farm was built in 1947 for added storage capacity.

The operating capacity of these first-generation tank farms was quickly reached and new second-generation tanks were constructed. Tanks built at the 241-BY, 241-S, 241-TX, and 241-TY Tank Farms between 1948 and 1953 provided a 750,000-gal storage capacity. These tanks have the same diameter and general construction as the first generation of tanks but have an increased working depth. Third-generation tanks were built between 1954 and 1963 at the 241-A, 241-AX, and 241-SX Tank Farms. These tanks were designed to provide 1,000,000 gal of storage capacity. Third-generation tanks also have a different design and construction than earlier generations of tanks. With each new tank farm, additional diversion boxes were added, as well as additional pipelines and related ancillary equipment.

In 1966, the design of tanks changed from a single, steel-lined concrete wall to an inner steel and outer concrete wall design. Between 1966 and 1986, DST designs were used for the remaining six farms: 241-SY, 241-AN, 241-AP, 241-AW, 241-AY, and 241-AZ. These tanks are much smaller in size but have an increased capacity to handle high-heat loads associated with self-boiling, high-level/high-activity wastes generated at the REDOX and PUREX facilities.

Also associated with both the SST and DST tank farms are several tank evaporators or solidification systems. Large-scale evaporators were constructed near the 241-B, 241-T, 241-S, and 241-A Tank Farms. The 242-B evaporator was constructed in 1951 to process first-cycle wastes from the bismuth phosphate process in the 241-B Tank Farm. The evaporator ran between December 1951 and November 1954, reclaiming over 7 million gal of tank space. The 242-T evaporator is located within the shared fence line of the TX and TY Tank Farms. The evaporator was constructed in 1950 and evaporated T, TX, and TY tank wastes until 1976, when it was then converted for the neutralization of Z Plant wastes and later supported the salt-well pumping program. The 242-S evaporator, located north of and adjacent to the 241-S Tank Farm, operated between 1973 and 1980 and was used to reduce waste volumes in the 241-S and SX Tank Farms. The 242-S evaporator is currently shut down and is not expected to be re-started.

The 241-A evaporator was built between 1974 and 1977 and is located in the southeast corner of the 241-A Tank Farm. This evaporator is an integral, operating part of current and future (through 2018) waste retrieval and management activities. The 242-A evaporator has been used to reduce the waste volume at a number of tank farms and has helped limit the number of DSTs required to store liquid waste generated at the Hanford Site.

Two in-tank-solidification (ITS) systems were installed the 241-BY Tank Farm. ITS#1, which used heated air circulated through tank waste, was installed for tanks BY-101 and BY-102 and began operation in 1965. ITS#2, using an in-tank heater, was installed first in tanks BY-111 and BY-112 and operated between 1968 and 1974. The ITS#2 design was extended to the remaining BY tanks by 1971, and ITS#1 was converted to a cooler for ITS#2. The ITS process was superseded by salt-well pumping and was shut down in 1974.

Outside the tank farm fence lines, a great number of pipelines and ancillary equipment were constructed to support plant operations and waste transfers. At least 100 mi of pipelines and numerous diversion boxes, catch tanks, and vaults are known. Pipelines used to transfer high-level/high-activity wastes were initially buried directly in trenches. A series of failures in the 1940s led to a design where up to 15 pipelines were placed in covered, below-ground, concrete troughs, or encasements. The encasements extended between diversion boxes and were designed so liquids lost in pipeline leaks drained into a diversion box or catch tank. Catch tank liquids could be pumped out and returned to the tank farm or processing facility. More recently, pipe-in-pipe designs have replaced encasements.

2.2.2 Process Information

2.2.2.1 Facility Processes

The 200-IS-1 and 200-ST-1 OU waste sites received waste from several 200 Area processes, including the following:

- Bismuth phosphate/lanthanum fluoride
- URP, UO_3 operations, and scavenging operations
- REDOX
- PUREX
- Isotope (strontium/cesium) separations, recovery, and storage operations
- PFP operations, machining, and plutonium/americium scrap recovery processes (i.e., RECUPLEX, PRF, and americium recovery)
- Tanks waste evaporation/solidification operations.

The 200-ST-1 OU waste site are only associated with receiving septic waste from non-process-related operations. The processes conducted in the 200 Areas that generated the primary waste streams impacting with the 200-IS-1 OU waste sites included the processes are discussed in the following subsections.

2.2.2.1.1 Bismuth Phosphate/Lanthanum Fluoride. The bismuth phosphate process used sodium hydroxide to remove the aluminum cladding and concentrated nitric acid to dissolve the fuel rods. Bismuth phosphate and bismuth oxynitrate were used to support precipitation of plutonium; hydrogen peroxide, sodium dichromate, ferrous hydroxide, and ferrous ammonium sulfates were used to change the plutonium valence states during the oxidation/precipitation reactions. Phosphoric, sulfuric, and nitric acids were added to dissolve the precipitates formed.

In the bismuth phosphate process, the bismuth phosphate preferentially attracted plutonium from the solution; the plutonium, as a precipitate, was separated physically by centrifuging.

The lanthanum fluoride process further purified the dilute plutonium solution created in the last step of the bismuth phosphate process. The dilute plutonium nitrate supernatant was oxidized with sodium metabismuthate. Phosphoric acid was added to precipitate impurities, and the resulting solution was treated with oxalic and hydrofluoric acids and lanthanum salt. Consequently, lanthanum fluoride and plutonium fluorides were co-precipitated. The lanthanum and plutonium fluoride solids then were converted to hydroxides by the addition of a hot potassium hydroxide solution. The hydroxides were washed with water, dissolved in nitric acid, and heated to form a concentrated plutonium nitrate solution. This solution was sent to the isolation building (231-Z) for further purification treatments and evaporation. A concentrated plutonium nitrate paste was the final product. Every 760-L (200-gal) batch of dilute, unpurified plutonium solution entering the 224-B/T Building yielded an estimated 30 L (8 gal) of purified concentrated weapons-grade plutonium (HW-10475, *Hanford Engineer Works Technical Manual [T/B Plants]*).

2.2.2.1.2 Uranium Recovery Process, UO_3 Plant, and Scavenging Operations. The URP was implemented at U Plant to recover the spent uranium from the metal waste and first-cycle waste streams generated during the bismuth phosphate process for reuse in weapons-grade plutonium production. The URP was performed in three phases. The first phase consisted of removing bismuth phosphate waste (i.e., metal waste, first-cycle supernatants, and cell 5 and 6 drainage) from the C, U, T, TX, TY, B, BX, and BY Tank Farms and preparing the sludge-slurry solution using nitric acid to dissolve the uranium metal and jet it into U Plant. A second phase consisted of using a solvent-extraction process to separate the uranium from the remaining plutonium, fission products, and chemicals. The counter-current, solvent-extraction process used TBP in a NPH diluant (e.g., AMSCO or kerosene) that was less dense than water and assisted in the mass transfer of the separation process. Sulfamic acid and ferrous ammonia sulfate were used to ensure that the correct valence states of the uranium was obtained. The separated UNH was then sent to the 224-U Building or the UO_3 Plant, where it was heated to approximately 204°C (400°F) to drive off nitrate and water, which resulted in UO_3. The UO_3 powder was removed from the vessels, packaged, and shipped offsite, where it was then converted to uranium metal. The uranium metal was sent back to Hanford's 300 Area to be reincorporated into the uranium fuel rod production process (HW-19140, *Uranium Recovery Technical Manual*).

In 1953, tests to further treat URP aqueous waste streams generated during the bismuth phosphate campaign proved successful. The "scavenging" process precipitated the long-lived fission products (including strontium-90 and cesium-137) from the waste solutions by the addition of a metal/ferrous cyanide complex. The metals that were most notable and widely used to assist precipitation were iron, nickel, and cobalt. Calcium nitrate and/or strontium nitrate often were added to enhance the precipitation of strontium-90. Phosphate ions also were added to help the soil retain strontium-90. After the TBP waste had been scavenged, it was returned to the B, BX, BY, T, TX, and TY Tank Farms to allow the solids containing the fission products and scavenging chemicals to settle. The waste liquid was sampled from the tanks at various depths and analyzed before the liquid effluent was sent to cribs and/or trenches, depending on the concentrations of cesium-137 and strontium-90, or was re-routed to other nearby tanks where settling continued or "in-tank" scavenging occurred. In-tank scavenging was actually the addition of the ferrous cyanide complex to tank waste in tank farm vaults, not tanks. The waste was then routed back to the tank, allowing it to settle. Samples were obtained of the supernatant. If the liquid was within "cribbable" or "trenchable" limits, the liquid was then routed out of the farm to vadose disposal sites.

2.2.2.1.3 Reduction-Oxidation. The REDOX process was a solvent-extraction process that removed plutonium and uranium from dissolved fuel rods into a methyl isobutyl ketone (MIBK, or hexone) solvent. The solvent-extraction process was based on the preferential distribution of uranyl nitrate and the nitrates of plutonium between an aqueous phase and an immiscible organic phase (DOE/RL-91-60). The REDOX process included fuel decladding with a boiling sodium hydroxide or sodium nitrate solution for aluminum-based cladding or a boiling ammonium fluoride and ammonium nitrate solution for zirconium-based claddings. Feed dissolution using concentrated nitric acid, and plutonium oxidation using potassium permanganate and sodium dichromate were completed simultaneously. The prepared feed entered the packed, counter-current, solvent-extraction column where acidified hexone was fed to the column from the bottom and the aqueous phase (ANN scrub solution or salting agent) was fed to the column from the top. The aqueous solubility of the uranium and plutonium nitrates was reduced by increasing the nitrate concentration in the aqueous phase and modifying other reaction parameters (e.g., temperature and pH). The uranium and plutonium were extracted into the organic phase and routed to the second series of purification/extraction columns, while the fission products remained in the aqueous phase and were routed to the tank farms. Uranium and plutonium (present in the organic phase) were chemically separated in the second series of extraction columns using a ferrous sulfamate solution containing ANN to reduce the plutonium to the +III valence state. Additional purification cycles of uranium and plutonium were conducted in the third series of extraction columns using the same chemical constituents. The solvent was recovered and recycled back into the process after treatment, sampling, and analysis (HW-18700, *REDOX Technical Manual*).

2.2.2.1.4 PUREX. The PUREX process used a recyclable salting agent, nitric acid (which greatly lessened the cost and the amount of waste generated), and TBP in an NPH solution as an extraction solvent. Fuel decladding was performed using a boiling sodium hydroxide or sodium nitrate solution for aluminum-based claddings or a boiling ammonium fluoride and ammonium nitrate solution for zirconium-based claddings. Feed dissolution used concentrated nitric acid and ANN. The prepared feed entered the pulsing, counter-current, solvent-extraction column where TBP diluted in NPH was fed to the column from the bottom, and the aqueous phase (sodium nitrite or nitric acid salting agent solution) was fed to the column from the top. Dilute nitric acid, ferrous sulfamate, and sulfamic acid descended from the top of the second column to remove uranium and neptunium from plutonium. Chemical separation processes were based on conducting multiple purification extraction operations on the resulting aqueous nitrate solutions containing each of the separated products in a second and third series of extraction columns, similar to REDOX operations. The driving forces for the separations consisted of varying partition coefficients between the aqueous and organic phases, controlled by valence-state changes of the element of interest (DOE/RL-92-04, *PUREX Plant Source Aggregate Area Management Study Report*). The solvent and salting agents (e.g., nitric acid) were recovered, treated, sampled, analyzed, and recycled back into the process operations.

2.2.2.1.5 Isotope (Strontium/Cesium) Separations, Recovery, and Storage Operations. The 221-B Building is one of the primary B Plant facilities. It began various waste treatment operations in 1965. In 1968, it was used to in the isotope separations, recovery, and storage program to recover cesium and strontium. Since 1968, several new structures have been added to the 221-B Building, such as 225-B WESF and the 212-B Cask Transfer Facility.

In 1963, the 221-B Building began recovering strontium, cerium, and rare earth metals using an acid-side, oxalate-precipitation process as part of the Phase I processing for the 221-B Building Waste Fractionalization Project. A centrifuge was used to separate the phases. The lead, cerium, and rare-earth fractions were dissolved in nitric acid and stored. The strontium fraction was thermally concentrated and stored. Portions of the strontium and rare earths produced in Phase I were pumped by underground transfer line to the Hot Semi-Works Facility for purification of the strontium-90 fraction and separation of the rare-earth fraction in cerium-144 and a rare-earth fraction including promethium-147. Phase I processing at the 221-B Building ended in June 1966 to accommodate Phase II construction (DOE/RL-92-05).

The objective of Phase I processing was to restore services to the 221-B Building after its extended shutdown and to accumulate an inventory of fission products. The Phase II portion of the project was the installation of facilities necessary to demonstrate a process system for packaging the long-lived fission products as a small-volume concentrated waste (Phase III). The purpose of Phase III was to provide waste fractionalization facilities in the 221-B Building for reprocessing high-level/high-activity wastes from PUREX Plant and the B Plant tank farms into fractions that could be immobilized and contained more safely (DOE/RL-92-05).

The Phase III waste fractionalization processing began at the 221-B Building in 1968. This process separated the long-lived radionuclides, strontium-90 and cesium-137, from high-level PUREX and REDOX wastes and stored a concentrated solution of strontium-90 and cesium-137 at the 221-B Building. Individual tanks at the B Plant contained up to 35 MCi of strontium-90 and cesium-137 at concentrations up to 10,000 Ci/gal. The combined storage capacity of the tanks was estimated to be 85 MCi of strontium-90 and 25 MCi of cesium-137 (DOE/RL-92-05).

Three processes were used for the waste fractionalization. The first process was the feed preparation and solvent extraction of current acid wastes generated by the 202-A Building and stored at PUREX Plant and REDOX tank farms. The solids in these wastes contained about 55% of the strontium and 70% of the rare earths. The solids, consisting mostly of silicates, phosphates, and sulfates, were treated by a carbonate-hydroxide metathesis solution to convert the sulfates to carbonate-hydroxide solids. These solids were then separated from the solution by centrifuge and dissolved in nitric acid to recover the fission products. The dissolved fission products were combined with original acid waste supernate after it had been treated to form feed for the solvent-extraction columns by adding a metal-ion complexing agent, a pH buffer, and a pH adjustment solution (DOE/RL-92-05).

The feed went through a series of solvent-extraction columns. The solvent used was a mixture of di(2-ethylhexyl) phosphoric acid extractant and TBP modifier in a NPH diluent. The strontium, cerium, and other rare earths were extracted from the aqueous phase into the solvent. The aqueous fraction contained the cesium and was routed to the 241-A or 241-AX underground tank farms in the PUREX Plant for temporary storage to allow the decay of short-lived activity (DOE/RL-92-05).

The strontium fraction was stripped from the solvent with dilute nitric acid and thermally concentrated with the cell 5 concentrator for storage in tanks in the 221-B Building's cells 6 through 8. The cerium and rare-earth fraction was stripped from its solvent with nitric acid, combined with organic wash wastes, and sent to SST storage. The solvent was washed and recycled for reuse (DOE/RL-92-05).

The second process used was a feed preparation and solvent-extraction process for processing stored sludge wastes from the 241-A, 241-AX, and 241-SX Tank Farms. The sludge was sluiced with supernate and water and then pumped out of the tanks to the 244-AR or 244-SR vault. At these vaults, the sluicing water was decanted for storage to await treatment for cesium removal. The sludge, containing the bulk of the fission products, was dissolved in nitric acid and transferred to the 221-B Building for treatment (DOE/RL-92-05).

At the 221-B Building, the rare earths and strontium were precipitated as sulfates using lead sulfate as a carrier to separate them from iron and aluminum. A sodium hydroxide-sodium carbonate metathesis was performed to convert the sulfates to hydroxides and carbonates and to eliminate the bulk of the lead. The product cake was centrifuged, dissolved with nitric acid, and accumulated for solvent-extraction treatment. The solvent extraction was similar to the solvent extraction for the current acid waste. However, the aqueous waste fraction from the initial solvent-extraction (containing the rare earths and the solvent wash) wastes were thermally concentrated at the 221-B Building using the cell 20 concentrator and transferred to immobilization processing (ITS) (DOE/RL-92-05).

The third waste fractionation process was the IX of stored cesium supernates and sluicing solutions. High-level tank farm supernates and sluicing water-containing cesium-137 were passed through an IX column at the 221-B Building. The cesium and a small fraction of sodium were adsorbed on a synthetic alumino-silicate zeolite resin. About 97% of the adsorbed sodium and 0.5% of the loaded cesium were designed to be removed from the column with a dilute ammonium and carbonate-ammonium hydroxide scrub solution. Following this, the remaining cesium was removed with a concentrated mixture of ammonium carbonate and ammonium hydroxide. The cesium was thermally concentrated in the cell 20 concentrator and stored in tanks in 221-B Building cells 14 and 17. The waste from the adsorption step was routed directly to ITS. The column wash wastes and scrubs were thermally concentrated in the cell 23 concentrator prior to transfer to ITS. In 1974, the 221-B Building began using cell 38 to perform final purification of the cesium prior to processing at the WESF. The strontium solvent-extraction process operated until 1978. Cesium final purification was ended in 1983 and strontium purification was ended in 1984 (DOE/RL-92-05).

The waste fractionalization process included a thermal evaporation concentrator in cell 23 to concentrate process wastewater prior to disposal. This system was used to concentrate low-level radioactive waste after the cesium and strontium waste fractionalization process was shut down in 1984. The DST waste was received at the 221-B Building to be processed through the low-level waste concentrator until 1986. The 221-B Building did not receive DST wastes after April 1986, and processing of these wastes was completed by late 1986. Other sources of the low-level waste included miscellaneous sumps and drains in the WESF, which diverted decontamination waste solutions generated in the WESF process cells. Another contributor was a liquid collection system located beneath the 40 cells in the 221-B Building that collected cell drainage from decontamination work and water washdowns in the processing section of the 221-B Building (DOE/RL-92-05).

The concentrator process consisted of a vertical, single-pass, shell-and-tube, thermal-recirculated and steam-heated evaporator. The evaporator had two bundles of tubes that contained low-pressure steam to heat the process feed. The tube bundles heated the feed to the boiling point and vaporized it. The evaporated liquid passed through a high-efficiency de-entrainer to remove entrained liquid droplets and was condensed as process condensate.

2.2.2.1.6 Z Plant Complex. At the Z Plant complex, the recovered, purified plutonium was refined to one of several forms, depending on the era and the available process.

The PIF process at 231-Z was described as a batch-wise operation where concentrated plutonium nitrate solution was further reduced to a paste. The first step in the PIF process consisted of adding ammonium nitrate to the plutonium nitrate solution (received as the product from T and B Plants), which reduced the plutonium to the (+IV) valence state. Next, sulfates and peroxide were added to the mixture, causing plutonium to precipitate as plutonium peroxide. Nitric acid was added to this precipitate, forming a purer and more concentrated plutonium nitrate solution. Finally, this product was placed into small shipping containers and boiled using hot air to evaporate the liquid to form a wet plutonium nitrate paste. The PIF process waste likely contained minor amounts of fission products, plutonium, and other TRU elements.

The 234-5 Z Building housed the RG line operations. The RG line operations were performed in batches through a series of gloveboxes in which the operators handled the radioactive materials directly with their hands encased in rubber gloves. Several steps were involved with the RG line operations:

- Wet chemistry operations
- Dry chemistry operations
- Reduction to metal operations and casting
- Machining and review of product.

Plutonium feed in the form of a concentrated plutonium nitrate solution (produced in T and B Plants [bismuth phosphate process], the 202-S Building [REDOX operations], and later the 202-A Building [PUREX operations]) was transferred to the 234-5 Z Building for the beginning of the wet chemistry operations. The chief impurities in the concentrated plutonium nitrate were lanthanum and americium. The first step in removing these impurities was to perform two peroxide precipitations to adjust the valence state of the plutonium from (IV) to (VI) to facilitate impurity removal. Aluminum was then added to complex the fluoride ions present in solution. After the second-cycle precipitation, the plutonium oxide was redissolved in nitric acid and concentrated by evaporation to plutonium nitrate.

The plutonium nitrate solution was dissolved with hydroiodic acid in preparation for an oxalate strike. Dissolving the plutonium nitrate in hydroiodic acid changed the plutonium valence state from (IV) to (III). The oxalate was added with nitric acid and dilute peroxide, and a plutonium oxalate solid was formed. This solid was washed with a dilute solution of nitric and oxalic acid. The filtrate was treated with 4% potassium permanganate for 30 minutes at 65°C. After the plutonium oxalate solid was washed, the dry chemistry operations began. The solid was dried at 120°C to drive off the associated water. The temperature then was raised to 300°C to convert the plutonium oxalate to plutonium oxide by calcination.

To produce the metal, plutonium oxide and any residual plutonium oxalate first were converted to plutonium fluoride by reactions with hydrogen fluoride. The hydrogen fluoride was added at high temperatures over time (refluxing), which allowed the reaction to proceed to 100% completion (production of plutonium fluoride). The plutonium fluoride then was placed in a container, which was placed in a magnesium oxide crucible with calcium. A reducing charge was added to the crucible to convert the plutonium fluoride to plutonium metal at approximately 1,600°C. Gallium was used to alloy the plutonium metal to stabilize the delta phase during metal and oxide formation.

The liquid process waste was characterized as acidic and corrosive (pH of 2), high in salts, and low in organic content (except for the plutonium milling waste). The waste contained only minor amounts of fission products and low concentrations of plutonium and other TRU elements (WHC-EP-0342, Addendum 8, *Plutonium Finishing Plant Wastewater Stream-Specific Report*). The waste was high in nitrates in the form of nitric acid, aluminum nitrate, magnesium nitrate, ferric nitrate, and calcium nitrate. Other components were aluminum fluoride, potassium hydroxide, potassium fluoride, chromium, lead, and trace metal ions.

Process wastes, including process condensates, were discharged through the 241-Z treatment tank (tank D-5) where sodium hydroxide, ferric nitrate, and sodium nitrite were added for solubilization and neutralization. Corrosion inhibitors (e.g., sodium nitrite and aluminum compounds for solubilization) also were added in this tank. Before 1973, the waste was discharged via cribs to the soil column. Beginning in 1973, the treated waste was stored in underground SSTs and later in DSTs.

The RMA and RMC line operations replaced the RG line operation. The process remained the same chemically, so the waste also remained the same. Remotely operated mechanical equipment increased operation efficiency and reduced employee doses. The plutonium oxides were formed in magnesium-oxide crucibles. These hemispheres were reduced in the shape of a disk, or "button." The buttons were inspected and tested. From the early 1950s to late 1970s, the buttons were re-melted and cast into a finished shape. Cast forms were coated with nickel and polished so they could be handled without spreading plutonium contamination.

A mixture of lard oil and carbon tetrachloride was used for milling the plutonium metal. Other cutting solvents and hydraulic fluids (including polychlorinated biphenyls) also were used in the plutonium machine shop. The liquid process waste from the milling operations was characterized as high in organic content and contained only minor amounts of fission products and low concentrations of plutonium and other TRU elements. Milling process waste, including process condensates, was discharged through the 241-Z treatment tank (tank D-5) where it was mixed with other 234-5 Z Building liquid process waste and had sodium hydroxide, ferric nitrate, and sodium nitrite added for solubilization and neutralization. Corrosion inhibitors (e.g., sodium nitrite and aluminum compounds for solubilization) also were added in this tank. Before 1973, the waste was discharged via cribs to the soil column. Beginning in 1973, this treated waste was stored in SSTs (and later in DSTs) and/or packaged in absorbent inside 207-L (55-gal) drums and routed to burial grounds in low-level waste management areas (LLWMAs) in the 200 West Area.

The RECUPLEX Facility was also housed in the 234-5 Z Building. The RECUPLEX Facility was used to purify plutonium scrap and solutions from 1955 to 1962. The process was a batch-wise, solvent-extraction technology based on the formation of an organic plutonium complex that was preferentially soluble in an organic solvent. This process used nitric and hydrofluoric acids to dissolve plutonium solids into plutonium nitrate liquid and a TBP-carbon tetrachloride solvent to recover plutonium from the plutonium nitrate solutions. An 85:15 ratio by volume of carbon tetrachloride to TBP was used. Other ratios were tested during the pilot plant treatability tests, but the 85:15 ratio provided the most satisfactory results for recovering plutonium.

The PRF replaced the RECUPLEX process line after a criticality accident forced the closure of the RECUPLEX unit in April 1962. The PRF operated from 1964 to 1979, and again from 1984 to 1987 in the 236-Z Building. The PRF had essentially the same mission as the RECUPLEX process line and used a similar solvent-extraction column technology. The extraction solvent used was carbon tetrachloride-TBP in a 80:20 ratio by volume, whereas the ratio in the RECUPLEX process was 85:15. Spent aqueous and organic wastes from the PRF were disposed to the soil column through a series of cribs until 1973.

The recovery of americium from PRF waste streams began in 1964 in the 242-Z Building. This facility was shut down in 1976 after a chemical explosion occurred in an IX column (known as the McClusky incident). The americium recovery process used an IX technique to recover americium from the waste streams. Elution and regeneration of the IX resin was performed with nitric acid. Americium was recovered in the PRF using a dibuty butyl phosphonate (DBBP) extractant in a carbon tetrachloride diluent. The DBBP was replaced in the process with TBP. Information on the waste generated from the americium recovery process was limited. Presumably, these waste streams would have included spent IX resins, organic solvent waste, and unrecovered americium, plutonium, uranium, and small amounts of fission products.

Currently, the Z Plant analytical and development laboratories are housed in the 234-5 Z Building. Analytical and development laboratories are reported to have been housed in the 231-Z Building as well. The laboratory provided analytical services and supported research and development activities for the various plutonium-finishing operations at the PFP (DOE/RL-2001-01, Rev. 0 [reissue] *200-PW-1 Plutonium-Rich/Organic-Rich Process Waste Group Operable Unit RI/FS Work Plan*). This support was provided in the following ways:

- Quality assurance and quality control for the plutonium processing lines
- Liquid scintillation counting
- Preparation work for solvent-extraction tests.

2.2.2.2 Tank Farm Evaporation/Solidification Processes

Changes to concentration and composition of both chemical and radiological constituents occurred as new waste streams were routed into tanks with an existing inventory. As tank farm capacity was reached, various methods to reduce the volume of liquids were implemented:

- For a few streams with lower activity levels, the waste was allowed to settle and was then sampled. If analyses indicated the liquid was within applicable limits, the streams were then discharged to cribs or trenches.
- Heating the waste to boil off excess liquid was also common and used both in-tank and free-standing evaporators built adjacent to the tank farms.

Each evaporation process required that one tank serve as the feed tank and that the concentrated wastes were returned to other tanks.

Wastes stored in the tank farms were recognized initially as a source for uranium and later for specific fission products. The resulting recovery processes required that tank wastes be mobilized and transported by pipelines to the process facility where recovery of the target component was undertaken. These wastes usually required chemical additions to reduce the potential for clogging. The residual waste materials were returned to the same or other tank farms for storage and again may have been treated to avoid undesirable chemical or physical reactions. Once the "scavenging" complexes had been added in U Plant or in the tank farm vaults and the solids settled, the liquid supernatants were sampled and routed to cribs and trenches.

To generate additional tank space, ITS or heaters were used in the 241-BY Tank Farm, and initially two evaporators were constructed and used (242-T and 242-B). Waste was routed from the feed tank to pre-heater (stainless-steel) tanks. The tanks had heating coils and were heated by steam produced during evaporator operations. In the evaporator, the feed was mixed with recycled liquid streams from the cyclone separator and packed scrubber to prevent the precipitation of aluminum hydroxide and/or nitrates (known as "dry solids"). A slight vacuum was often applied to the system to assist boiling. Evaporated process supernatants, or "overheads," were routed to the cyclone separator and packed scrubber. The resulting steam was sent back through the heating coils, and the condensed liquid was recycled back into the evaporator. The evaporator "bottoms," or slurries, were routed under pressure to the receiver tank and then to final storage (RL-SEP-396, *242-T Evaporator Facility Information Manual*).

Two additional evaporators (242-S and 242-A) were constructed, and the vacuum evaporator-crystallizer process began in 1973. Basically, the feed was mixed with the recycled stream, as in the process above. However, the mixed feed entered the evaporation system through a pipe, where it was then heated by steam contacting the piping rather than direct contact. Liquid was sent to a vapor-liquid separator that was maintained at 40 Torr. Under this reduced pressure, a fraction of the water in the salt-slurry concentrate flashed to steam and was drawn through two wire-mesh, de-entrainer pads in a vapor line, and then proceeded to the condenser. As evaporation continued in the separator, supersaturation of the dissolved salts increased and crystallization occurred. To support this continuous flow operation, the bulk of the slurry (consisting of salt cake and interstitial liquids) was retained and recirculated in the system while a small portion was routed to the selected slurry receiver tanks. The solids settled and the supernate was pumped back into the evaporation system (ARH-F-101, *Vacuum Evaporator-Crystallizer Flowsheet for Waste Liquors*).

Within the evaporator, process off-gases and water vapor are passed through one primary and two secondary condensers, creating the process condensate and a gaseous effluent. Gaseous effluents are filtered and released to the environment from the vessel ventilation exhaust system. Process condensate is collected in a condensate collection tank and pumped directly to the Liquid Effluent Retention Facility (LERF) or used in the process condensate recycle system. In the past, if the process condensate required additional cesium and strontium removal, it was processed though IX columns before discharge to LERF. The IX columns have been removed because treatment is provided at the Effluent Treatment Facility. Cooling water from the process vapor condensers and steam condensate stream is discharged to Treated Effluent Disposal Facility pump station #3 (HNF-14755, *Documented Safety Analysis for the 242-A Evaporator*). Two active diversion facilities associated with 242-A evaporator operations are located in the 241-A SST tank farm and the 241-A-A and 241-A-B valve pits.

As a result of these operations, it is generally assumed that most pipelines and diversion boxes directing high-level/high-activity wastes over a period of 40 years have transported a variety of wastes, no specific stream inventory can be directly attributed to a given line, and a combination of all 200 Area waste streams is possible. It also appears that standard practice dictated rinsing pipelines with several thousand gallons of water after a transfer was completed. In some lines that became clogged, there may be a reasonable understanding of radioactive and chemical constituents in the line.

2.2.3 Waste Site Descriptions

2.2.3.1 Pipelines and Diversion Boxes

Outside the tank farm WMAs, a variety of ancillary equipment and pipelines supported daily operations and waste transfers. This work plan focuses on the pipelines, diversion boxes, catch tanks, and associated waste sites that are located outside of the tank farm WMAs. This infrastructure was used to connect the SSTs and DSTs to separations facilities, evaporators, and other tank farms. The combined length of all of the pipelines in this service is conservatively estimated to be over 100 mi. At present, 12 diversion boxes and 10 catch tanks are considered in this work plan. The WIDS database designates waste site identification numbers for most of the diversion boxes and catch tanks outside the WMAs, but not for the complete network of pipelines.

Virtually all of the materials associated with separations processing were handled in liquid form. As a result, an extensive network of pipelines, diversion boxes, catch tanks, valve pits, retention basins, vaults, and related structures was used to transport process wastes from the separations facilities to the SSTs and DSTs, evaporators, and effluent discharge waste sites. An encased, cross-site transfer line connected the 200 East and 200 West Areas. Structures designed to handle high-activity radioactive wastes were given the "241-" numerical prefix, whereas those structures that handled low-activity radioactive wastes were designated as "207-" or "216-" structures. Most diversion boxes associated with cribs are not labeled and are generally considered to be part of the crib. A large number of the "241-" structures located inside the boundaries of the six 200 Area tank farm WMAs are not considered to be part of the 200-IS-1 OU; however, those "241-" structures located outside the tank farm WMAs are included in this OU. The "216-" structures were located near and were used to control/divert flow between parallel waste sites receiving the same low- to-moderate-activity waste streams. For larger cribs, flow was often routed into lower sections by a parallel crib distribution line. The "241-" tanks/lines/boxes/pits located inside the tank farms WMAs are addressed in the tank farms closure plan (RPP-13774, Rev. 2, *Single-Shell Tank System Closure Plan*). Other facilities in the 200 Areas (e.g., 240-, 242-, 243-, and 244-) with associated tanks, lines, and diversion boxes or valve pits are not included in this OU, but the approach presented in this work plan may be applicable to these structures.

The 200-IS-1 OU pipelines and associated structures within the 200 Areas that are identified by a waste site number and are currently being tracked within WIDS, are shown on Plate Maps 1, 2, and 3. In addition, those UPR waste sites that have a surface expression and are known or assumed to have been caused by a release from a 200-IS-1 structure, are also identified in WIDS, and are shown on the plate maps. The task of compiling, evaluating, and recording complete pipeline routing paths from points of inception (process facilities and/or tank farms) to disposal locations (trenches, cribs, ponds, etc.) or storage locations (tank farm WMAs) is currently proceeding but has not been completed.

The general representation of the liquid waste stream routing network in the 200 Areas is presented in Figure 2-7. During historical plant operations, the disposal or storage destination for a particular liquid waste stream was most often determined by composition and radiological activity levels. Figure 2-7 schematically shows the general pipeline and diversion box layout and the associated waste streams transported through different segments of the network.

Waste stream characteristics (e.g., corrosiveness, acidity, and radiological activity) were considered during design and construction of the pipeline network over the last 50 years at Hanford. Other factors related to the waste stream's destination (tanks, cribs, trenches, etc.) determined whether the liquid waste stream needed to be moved through the lines under pressure or could flow by gravity. The following discussion outlines the general waste streams handled by the pipelines and the physical characteristics of the pipelines that carried these liquids. Additional information has been compiled concerning pipeline physical characteristics, such as depth of burial and leak potential. Appendix F presents a summary of this attribute information as it applies to the pipelines and diversion boxes currently included within the 200-IS-1 OU.

2.2.3.1.1 Pipelines Carrying Low-Activity Radioactive Waste Streams. Process fluids consisted of steam condensate, chemical sewer waste, and cooling water. These waste streams were routed from facilities and tank farms to ditches and ponds. Pipeline composition varies widely and includes carbon steel, stainless steel, plastic, fiberglass, vitrified clay, concrete, and corrugated steel. Pipeline diameters are generally larger for this group of lines (ranging from 6 to 42 in. in diameter) than for other process fluid lines because of the need to handle larger volumes. These pipelines were generally nonpressurized, gravity-flow lines. Additional discussion concerning low-activity waste streams is provided in Appendix F. A generalized cross-sectional view of the burial characteristics of a single direct-buried pipeline is shown in Figure 2-8.

2.2.3.1.2 Pipelines Carrying Moderate-Activity Radioactive Waste Streams. Waste streams consisted mainly of process condensate from all major separations facilities and evaporators. These waste streams were sent to cribs, trenches, and injection wells. Tank and scavenged tank wastes also were sent through these lines, but in lesser volumes. Pipe compositions include vitrified clay (for resistance to acidic waste streams), iron, steel, stainless steel, and plastic. Pipeline diameters range from approximately 1 to 16 in. Most waste streams were transported under gravitational flow, except for the process fluids sent to the tank farms, which required pumping under pressure. Additional discussion concerning moderate activity waste streams is provided in Appendix F.

2.2.3.1.3 Pipelines Carrying High-Activity Radioactive Waste Streams. Pipelines used to transport high-activity wastes between tank farms or between facilities and tank farms are composed of welded stainless steel. Initially buried directly in the soil, these lines were later encased in concrete to prevent corrosion and contain leakage. Most often, more than one pipeline is present within an encasement. A generalized cross-sectional view of the burial characteristics for a typical multiple pipeline encasement is shown in Figure 2-9. The waste streams varied in concentration of radionuclides and chemical components. The pH of the waste stream had typically been adjusted to around 8 or greater. Waste stream constituents included transuranic radionuclides in some cases. Additional discussion concerning high-activity waste streams is provided in Appendix F.

2.2.3.2 Associated Waste Transfer Structures

2.2.3.2.1 Diversion Boxes. Diversion boxes are reinforced-concrete structures that have generally been constructed below grade. Transfer lines are connected in the diversion box by installing a jumper between the connecting nozzles. Diversion boxes provided a flexible method of directing liquid waste from a given point to virtually any other given point in the 200 East and 200 West Areas.

Diversion boxes were designed to establish or change waste transfer routes. They also provided containment for leaks in transfer lines (which drain back to the boxes via concrete or pipe-in-pipe encasements) and leaks at jumper-nozzle connections. The boxes are large, covered, underground, reinforced-concrete structures that received at least two (and up to four) sets of pipelines. The general configuration of a diversion box is shown in Figure 2-10. The pipe sets entered the diversion box at different levels through one wall. Each pipe had a special end-fitting that permitted the secure attachment of either flexible or solid pipes, also known as "jumpers." All connections were made manually using remote equipment. Each jumper was fabricated to custom fit to the desired pair of incoming and outgoing pipes. To assist with gravity flow, pipelines coming in from the facility were located on the higher level of pipes, while lines leading to tank farms were on the lower level. Connections could be routed for flow in either direction, as several of the separations processes retrieved wastes from the tank farms and transferred the material to the facility.

Diversion boxes varied in size but were typically 17 to 20 ft deep, by 6 to 10 ft wide, by 25 to 40 ft long. All but the uppermost portion of the diversion box was below ground. Each diversion box was covered with a series of thick-stepped cover blocks that prevented ready migration of contaminants out of the box. Cover blocks were removed when a routing change was required.

Connecting pipelines were either direct buried or were encased up to the outside wall of the diversion box. There they mated with pre-installed pipe that penetrated the box wall. Catch tanks were built at a level below that of the floor of the diversion box and collected wastes spilled in the box when routings were changed or when there was a spill or UPR. The jumpers are thought to have drained onto the floor when the connection was broken, leading to internal contamination of the box.

2.2.3.2.2 Catch Tanks. Catch tanks were built in conjunction with diversion boxes to contain high-activity wastes spilled during changes in pipeline routings. The tanks are direct-buried, underground storage tanks, generally constructed of carbon steel (Figure 2-10). Sump pits in the diversion box collected the liquid and piped it to the catch tank. With the advent of encased pipelines, leaks were also expected and provision was made to collect the liquid released into the nearest downgradient catch tank. In some cases, a catch tank served more than one diversion box, particularly around tank farms. The catch tanks were usually located within 50 ft of the diversion box. Frequently used catch tanks were empted to diversion boxes through an underground pump-out line. Each catch tank is equipped with a liquid-level sensor and a pump-pit leak indicator. Activation of the leak detection alarm caused a shutdown of transfer operations.

Catch tanks range between 7 and 9 ft in diameter and 25 to 35 ft long, with storage capacities of 8,000 to 12,000 gal. Catch tank designs changed as new diversion boxes were added to sitewide piping. Catch tanks were located at depths of 25 to 35 ft, considerably deeper than the floor of the diversion box to provide complete drainage of a leak or spill. A series of risers extended to above the ground surface and were used to monitor liquid levels, collect samples, pump out tank contents, and permit chemical additions. Steam jets or in-tank pumps were later added with piping that led back to the diversion box for ready transfer to the facility or tank farm. Some catch tanks have been replaced due to leaks or vessel failure.

2.2.3.2.3 Valve Pits. A valve pit or box is a below-ground, reinforced-concrete structure used to route wastes between pipelines leading to two waste sites. For a very long crib (up to 1,400 ft), valve pits were also used to more evenly distribute flow over both halves of the crib. These structures were most commonly associated with pipelines that relied on gravity flow of low-activity and moderate-activity waste streams and discharged to cribs, ponds, or ditches.

For some pits/boxes, pipelines passed through the structure with no open flow. Intersecting pipes were connected at tee or union fittings. Valves were built into the pipeline and were opened or closed to change flow routings. Other valve pits/boxes were designed to allow open wastewater flow within the pit. The incoming pipe terminated at the edge of the pit/box and water then flowed through the box before exiting at another pipeline. Changes in routing were through a series of moveable dams, or stop logs, as well as slide gates that covered the opening of the receiving pipe. Valve and gate handles were extended through the pit/box cover to permit remote operation.

Valve pits were generally smaller structures than diversion boxes. Sizes ranged up to 15 ft by 10 ft at the surface and they were constructed to depths up to 12 to 15 ft, depending on the depth of the buried pipeline. These structures usually carried a "216-" series prefix and a designation that was associated with the waste sites flow was directed to. Examples are known at a few crib pairs (216-A-8 and 216-A-24, and 216-S-5 and 216-S-6 with 216-S-16 Pond) and at the 216-A-25/216-B-3 pond system. The interiors of the valve pits could be accessed through hatches in the cover.

2.2.3.3 CX Tank System

The CX tank system is located east of B Plant, in the 200 East Area, within the Hot Semi-Works stabilized area (Figure 2-11). The 241-CX tank system consists of three tanks: 241-CX-70, 241-CX-71, and 241-CX-72. Although the Dangerous Waste Permit Application (Form 3) calls it the "241-CX tank system," these three tanks operated independently and served separate functions. The one thing that these tanks have in common is that they were decommissioned as part of the Hot Semi-Works Decommissioning Project. The 241-CX-70, 241-CX-71, and 241-CX-72 tanks were evaluated by (BHI-01018, Rev. 2, *Environmental Restoration Contractor Management Plan for Inactive Miscellaneous Underground Storage Tanks [IMUSTS]*) and determined to be safely managed as inactive waste sites under existing surveillance and maintenance programs. Processes that were associated with these three tanks are described below.

Tank 241-CX-70 was used for approximately 1 year in the early 1950s to store high-level process waste from the REDOX pilot studies (Figure 2-12). The design capacity of the tank is 113,550 L (30,000 gal). Waste removal activities for tank 241-CX-70 were initiated in the summer of 1987 with the construction of a sluicing/pumping system. The sluicing/pumping system involved using large volumes of water to sluice the solid waste mixed from tank

241-CX-70 and pump it to the DST system. Approximately 529,950 L (140,000 gal) of water were used to reduce the original waste volume of 38,986 L (10,300 gal) to 2,839 L (750 gal). This volume remained in tank 241-CX-70 until December 20, 1991, at which time the waste was placed in approved containers and transferred to the 224-T Transuranic Waste Storage and Assay Facility. As part of the 1991 waste removal activity, access to the manway and risers was required and resulted in excavating to the top of the tank. Plywood was used to shore up the excavations and was left in place following waste removal activities. In the spring of 2004, the shoring was observed to have collapsed and has since obscured the view of the tank. As part of the routine site safety surveys that will be conducted prior to any fiscal year 2005 (FY05) drilling activities around this tank, the area beneath the collapsed shoring will be inspected by camera to determine if unsafe conditions exist.

Tank 241-CX-71 was used from 1952 thorough 1957 for neutralizing 201-C process condensate and the coil and condenser cooling water (Figure 2-13). Tank 241-CX-71 received process condensate from REDOX and plutonium operations. The mixed waste remaining in tank 241-CX-71 contains liquid process effluents that were passed through the tank to be neutralized by contact with a bed of limestone aggregate placed in the tank for this purpose. After the June 1957 decontamination flushes, tank 241-CX-71 was taken out of service. The design capacity of tank 241-CX-71 is 3,785 L (1,000 gal).

Tank 241-CX-72 was used for approximately 1 year in 1956 when 8,725 L (2,305 gal) of Hot Semi-Works complex mixed waste was transferred into the tank for storage (Figure 2-14). Tank 241-CX-72 was used to study the self concentration of waste generated from the Hot Semi-Works complex pilot studies. Decontamination flushes from the Hot Semi-Works complex also might have been sent to tank 241-CX-72. The waste in the tank was then heated until it was nearly dry. Tank 241-CX-72 remained idle from 1960 until it was taken out of service in 1967. In 1986, tank 241-CX-72 was filled with 7.3 m (24 ft) of grout over a 3.4-m (11-ft) heel of non-liquid mixed waste. The design capacity of tank 241-CX-72 is 8,860 L (2,340 gal).

The RCRA Part A Permit Application (Form 3) was revised in 1994 and submitted to Ecology as Revision 3. The tanks are classified as dangerous waste tank TSD units with the following waste codes:

- <u>241-CX-70</u>: "D002" (corrosive) because of sodium hydroxide, and "D007" and "WT02" (dangerous toxic) because of chromium
- <u>241-CX-71</u>: "WT-02" (dangerous toxic – state only) because of cyanides and nitrates
- <u>241-CX-72</u>: "D002" (corrosive), "D004" (arsenic), "D005" (barium), "D006" (cadmium), "D007" (chromium), "D008" (lead), "D009" (mercury), "D010" (selenium), "D011" (silver), "WC02" and "WT01" (extremely hazardous toxic), and "WT02" (dangerous toxic – state only) because of cyanides and nitrates.

The CX tank system no longer receives waste and will be closed under interim status.

2.2.3.4 Hexone Storage and Treatment Facility

The HSTF is located in the southeast corner of the 200 West Area of the Hanford Site (Plate Map 2). The HSTF consisted of two 91,000-L (24,000-gal), below-grade, carbon-steel tanks (276-S-141 and 276-S-142), a distillation system, and railroad tank cars (Figure 2-15). The

HSTF received liquid mixed waste from the REDOX Plant and possibly the Hot Semi-Works Facility. The HSTF was used from 1951 through 1967 to store reagent-grade methyl isobutyl ketone (MIBK, or hexone) as a source of makeup solvent for the REDOX Plant. After 1967, the HSTF contained distilled hexone, part or all of which had been used in the REDOX Plant. Tank 276-S-142 also contained NPH and TBP from a one-time campaign to separate americium, curium, and promethium from Shippingport reactor blanket fuel in 1966. Approximately 760 L (200 gal) of water were added to tank 276-S-141 in 1988. Tank 276-S-142 received approximately 5,000 L (1,300 gal) of water in 1967; 1,900 L (500 gal) in the mid-1970s; and 760 L (200 gal) in the mid-1980s. The combined storage design capacity of tanks 276-S-141 and 276-S-142 is 182,000 L (48,000 gal). The treatment design capacity of the distillation system was 11,400 L (3,000 gal) of waste per day. The storage design capacity of the railroad tank cars was 152,000 L (40,000 gal).

The mixed waste was pumped from tanks 276-S-141 and 276-S-142 through a distillation system to decrease the radioactivity of the waste. The distilled waste was sent to temporary storage in railroad tank cars (located within the HSTF) until completion of transfers to an offsite incinerator in June 1992. Three distillation vessels containing process residue have been sampled and are stored at the Hanford Site as mixed waste. Tanks 276-S-141 and 276-S-142 each contain between 19 to 114 L (5 to 30 gal) of liquid mixed waste containing 93% NPH, 7% hexone, and up to 950 L (250 gal) of phosphate tar. The phosphate tar will be stored at Hanford as mixed waste. The railroad tank cars have been emptied, cleaned, and moved to another location. The two 91,000-L (24,000-gal), below-grade, carbon-steel tanks (276-S-141 and 276-S-142) are being closed under interim status.

A RCRA Dangerous Waste Permit Application (Form 3) for the hexone tanks was submitted to Ecology in December 1987 and was revised most recently in 1994. A RCRA closure plan for the tanks was submitted in November 1992 (DOE/RL-92-40). The tanks are regulated as dangerous waste tank TSD units with waste codes "D001" (ignitability), "F003" (listed spent hexone solvent), and "WT02" (toxicity criteria).

The hexone tanks had been safeguarded by a nitrogen purge almost continuously since 1992. This inert gas purge mitigates the risks associated with the hazardous vapors in the tanks. The purge prevented the collection of flammable vapor mixtures and eliminated the safety hazard to workers.

In April 2000, Ecology inspected the TSD unit encompassing the tanks. In May 2000, Ecology issued CCN 079387, *Notice of Correction for Stabilization of Hexone Storage and Treatment Facility*, regarding their findings. The letter required that the hexone tanks be stabilized by removing all of the potential safety hazards posed to employees by no later than December 2001. It also required that the stabilization include removal or deactivation of the waste. If the tanks remain in place, provisions must be made for monitoring the tanks for oxygen and organic vapors and for intrusion of liquids.

In May 2001, Ecology issued CCN 089928, *Notice of Correction for Stabilization of the Hexone Storage and Treatment Facility*, which revised the deadline for stabilizing the hexone tanks to the end of February 2002.

On December 13, 2001, Ecology approved grouting as the stabilization method for the hexone storage tanks (CCN 095038, *Approval for Stabilization of the Hexone Storage and Treatment Facility*). Ecology stipulated that each tank be grouted in two pours. In March 2002, the tanks were filled with cement grout using the method authorized by Ecology for stabilization and to reduce flammability concerns associated with hexone vapors. In each tank, the grout from first-pour covers the heel of waste with a distinctly colored grout. The first grout layer was allowed to solidify enough to introduce a cold joint between pours. After the first-pour grout solidified, the second layer of grout was poured into the tank. The second grout layer completely filled the tank's void space. The second pour consisted of uncolored grout that, in concert with the cold joint created between layers, provides a clear demarcation between the grout layers. The coloring and two-stage grouting processes facilitate closure of the tanks by separating the mixed waste contents (tank bottom containing the heel and colored grout) from non-mixed waste debris (upper tank and uncolored grout). The area is fenced off as a controlled access zone.

Ecology also requested that a revised closure plan for the hexone storage tanks be prepared for inclusion in future modifications to the Hanford Site's RCRA Sitewide Permit. Submittal of a revised hexone tank closure plan in conjunction with the 200-IS-1 and 200-ST-1 FS is currently planned.

2.2.3.5 2607-W3 Septic Tank

The 2607-W3 septic tank is a sanitary sewage disposal site consisting of a reinforced-concrete tank extending 15 cm (6 in.) above grade (Hanford Site drawing HW-71192, *Hanford Engineer Works Septic Tanks Plan and Sections*), with a 54,428-L (14,369-gal) capacity, located northeast of the 241-T-361 settling tank, approximately 61 m (200 ft) north of 23rd Street and 244 m (800 ft) southwest of the 224-T Building (Figure 2-16). This site also includes a drain field that was expanded in the 1950s to 134 m by 61 m (440 ft by 200 ft). The drain field's flow capacity was 18,685 L/day (4,933 gal/day) (WHC-SD-LL-ES-020, *200 Area Sanitary Waste Management Engineering Study*). The tank received sanitary effluent from the 221-T, 222-T, 224-T, and 271-T Buildings from 1944 until it was pumped, filled with sand, and abandoned in place in August 1996. Before being abandoned, the 2607-W3 septic system received 14,187 L/day (3,745 gal/day) of sanitary effluent. As shown in the WIDS database, a contaminated process sewer line runs parallel to the sanitary sewer line in this area.

Figure 2-1. Location of 200-IS-1 and 200-ST-1 Operable Units on the Hanford Site.

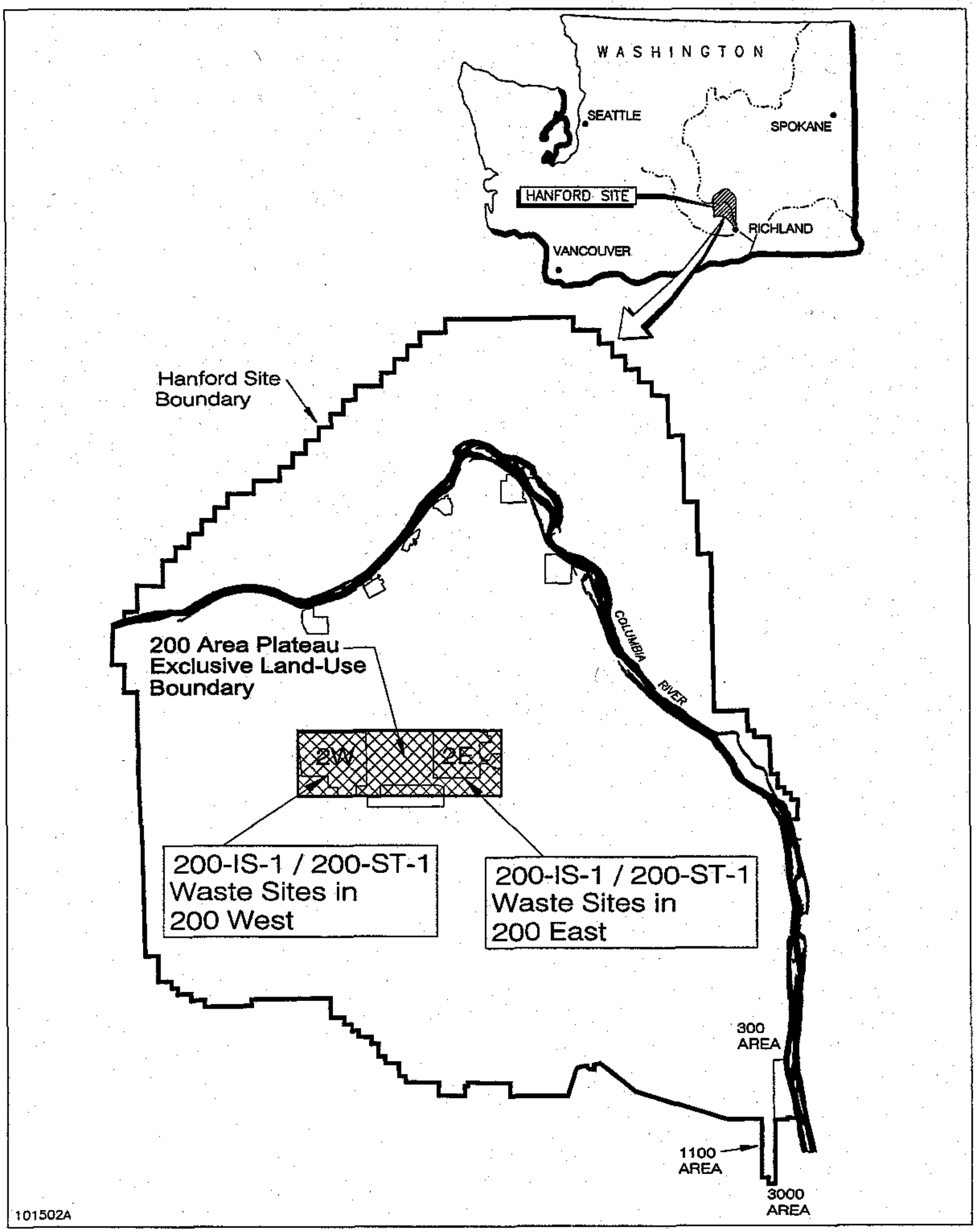


Figure 2-2. Generalized Stratigraphic Column for the 200 Areas.

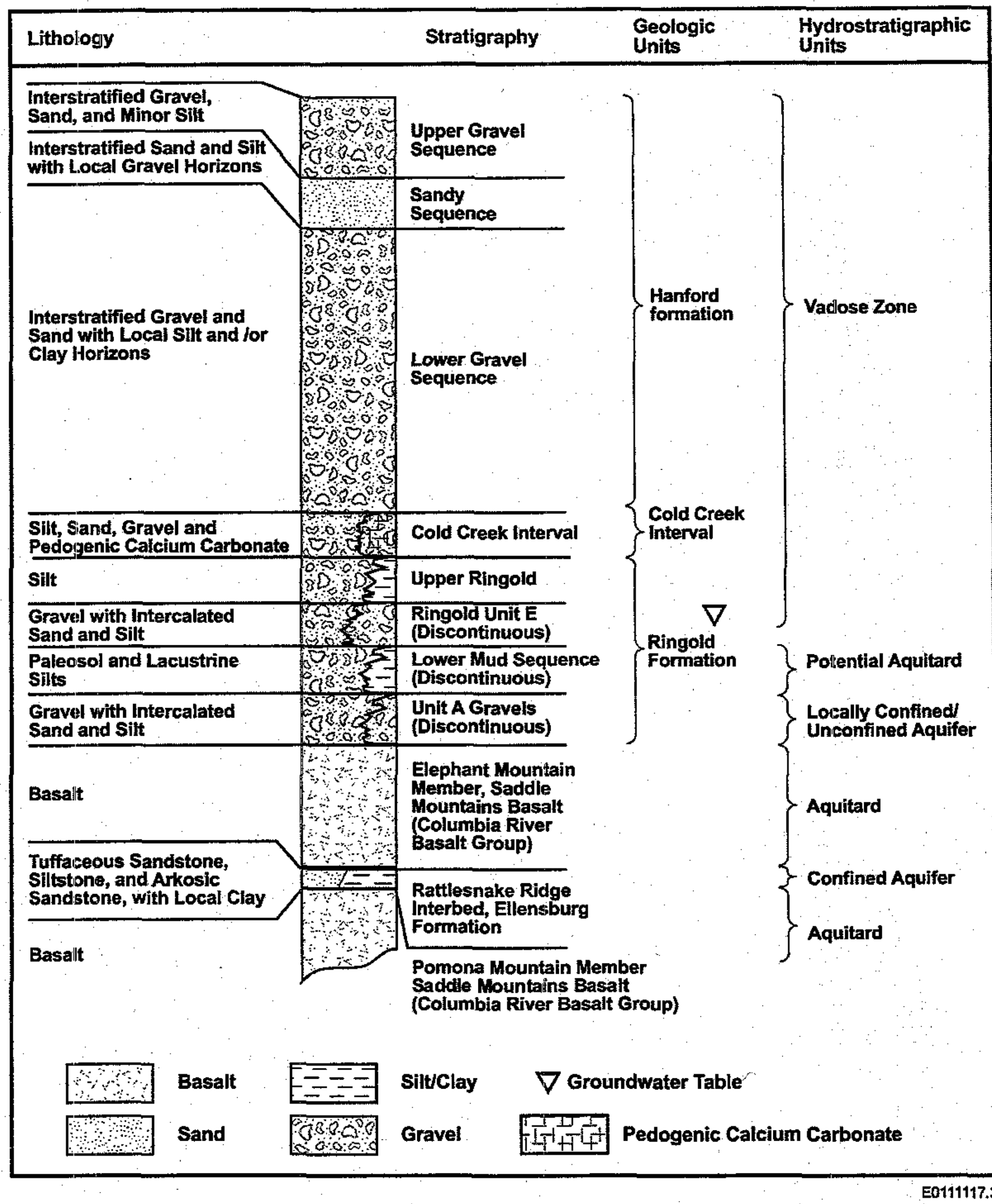
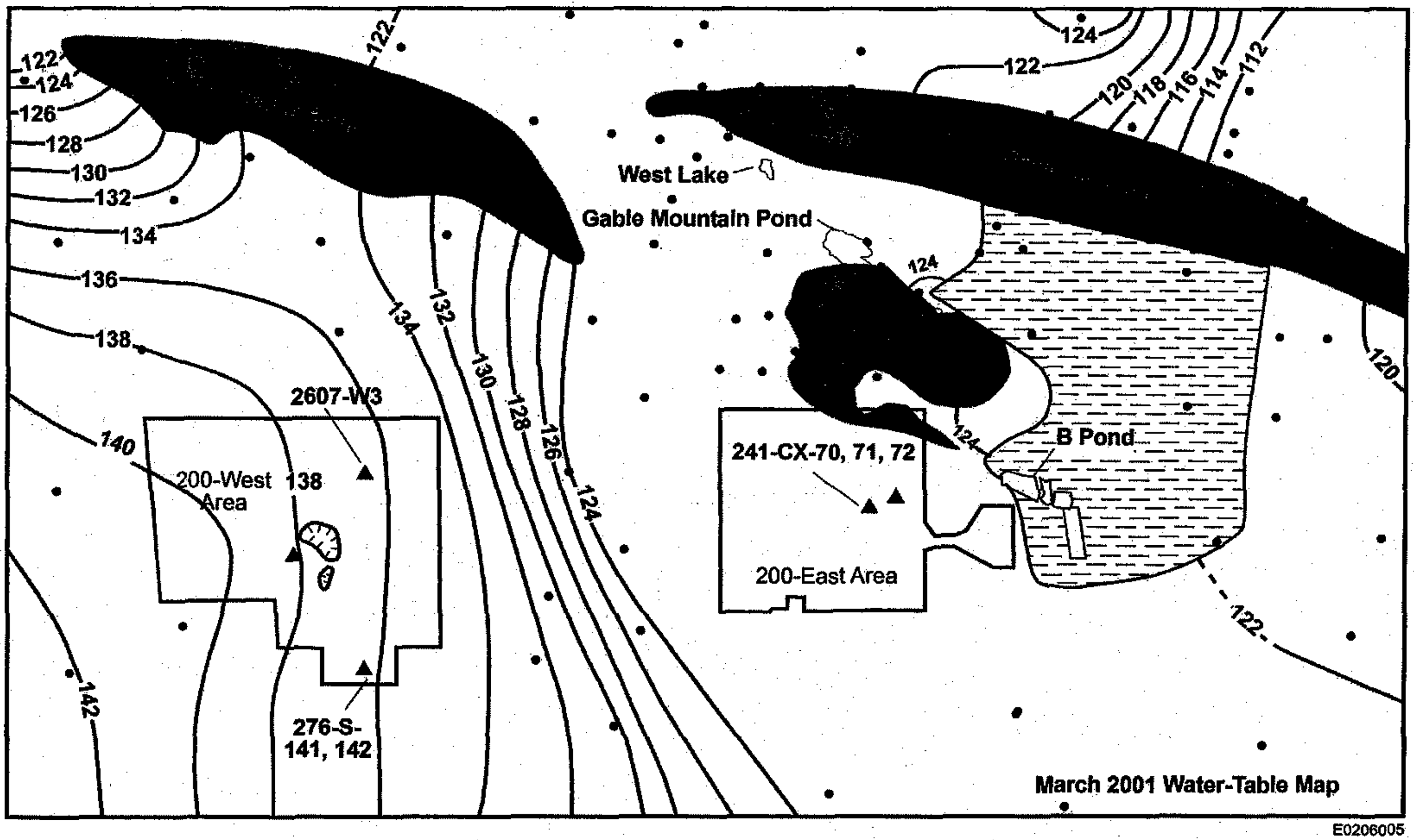


Figure 2-3. Groundwater Table Around the 200 East and 200 West Areas, April 2001.



Estimated Basalt Outcrop Above Water Table

100 Water-Table Elevation (meters), Dashed Where Inferred

Ringold Formation Lower Mud Above Water Table

● Monitoring Well ▲ Representative Sites

Vertical Datum: North American Vertical Datum of 1988 (NAVD88)

Figure 2-4. Stratigraphy Near the 241-CX-70, 241-CX-71, and 241-CX-72 Storage Tanks.

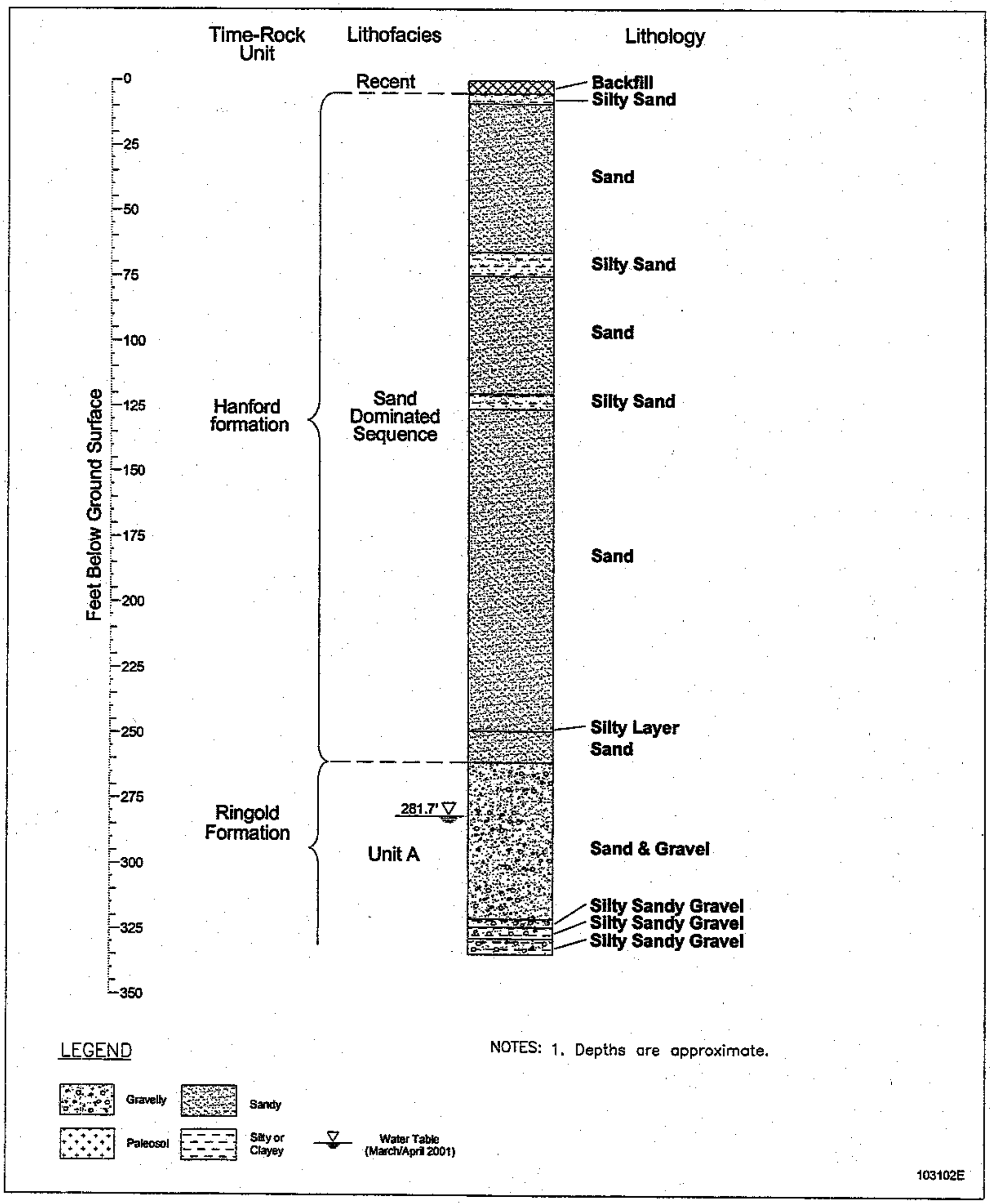


Figure 2-5. Stratigraphy Near the 276-S-141 and 276-S-142 Storage Tanks.

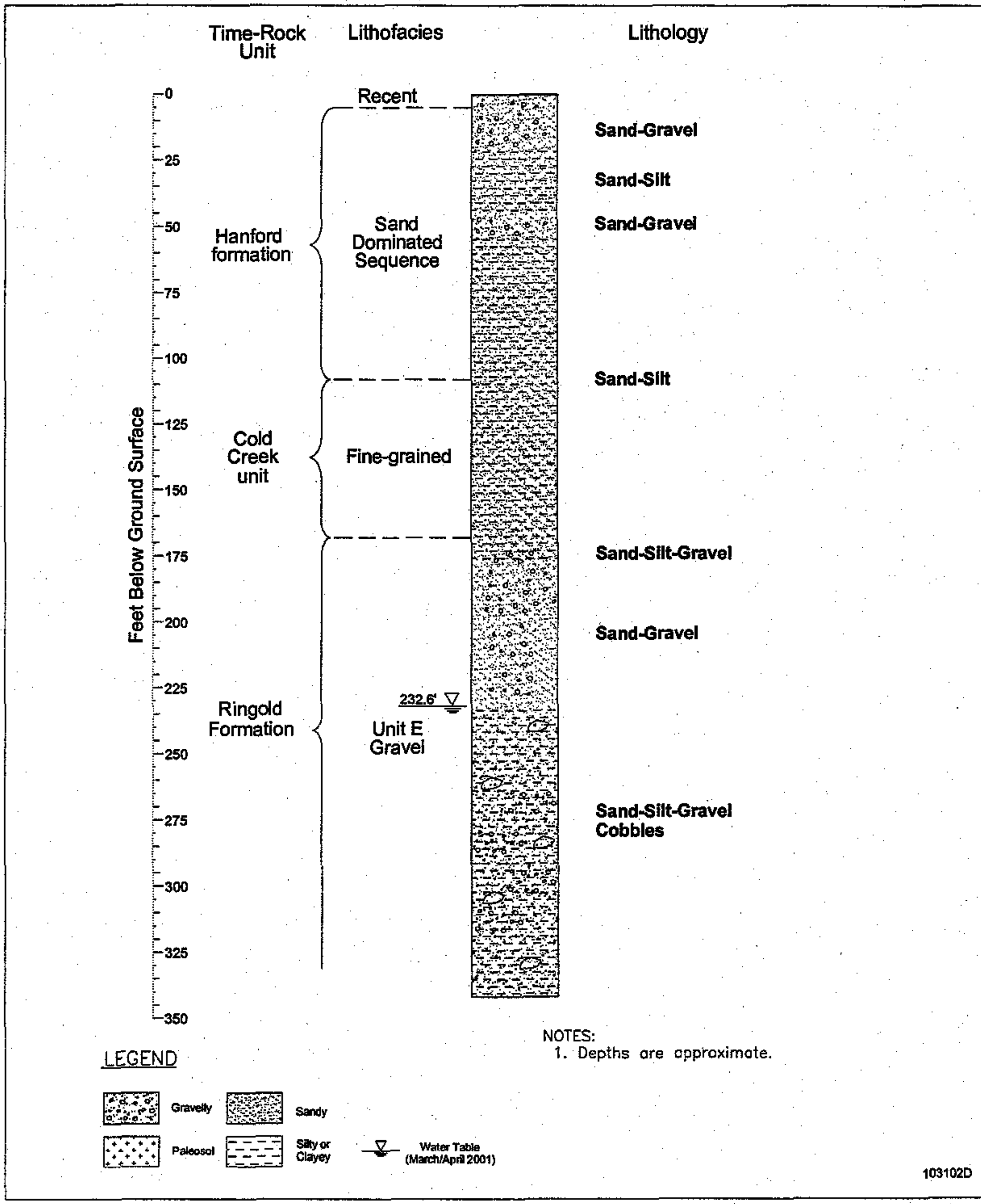


Figure 2-6. Stratigraphy Near the 2607-W3 Septic Tank.

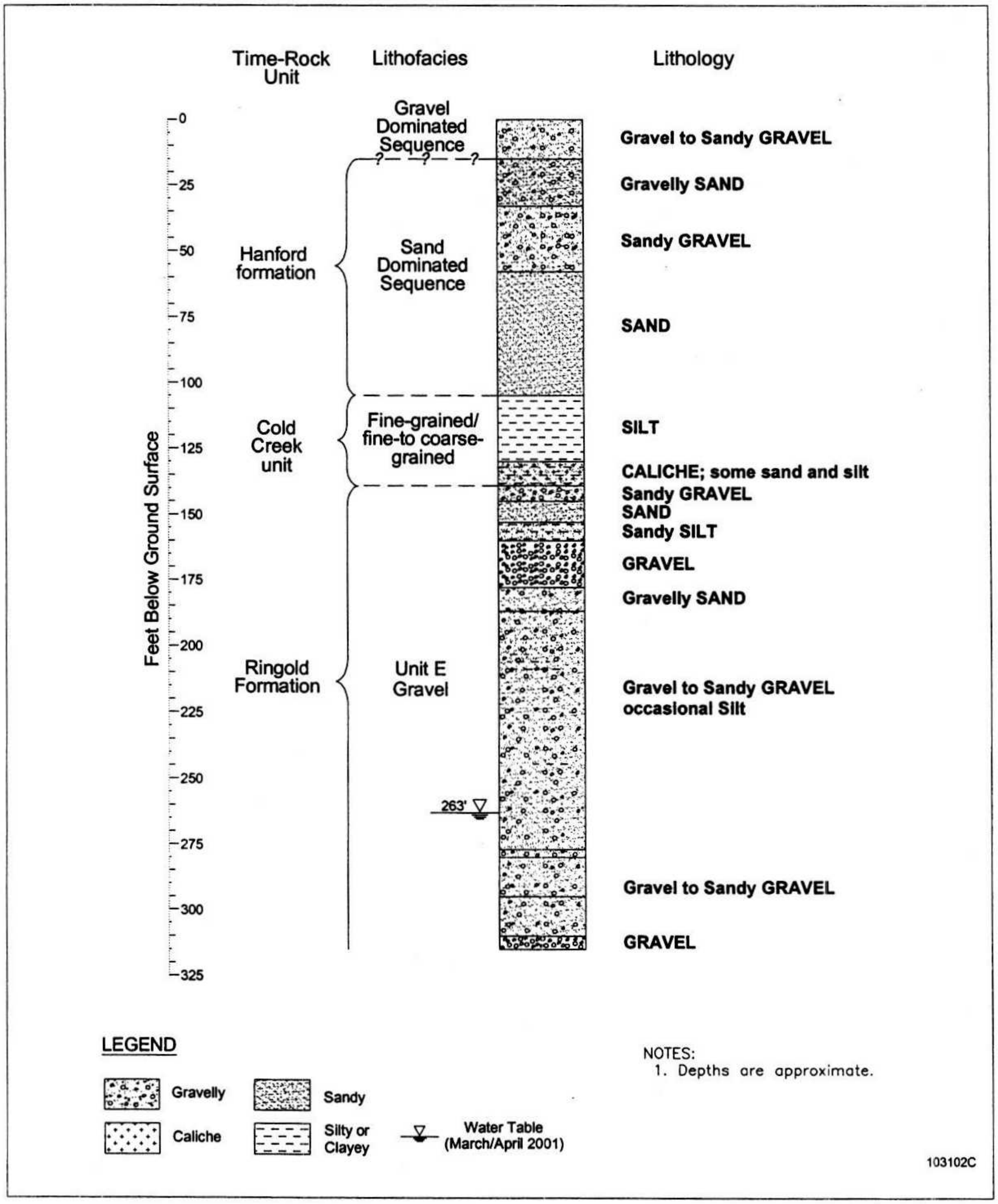


Figure 2-7. Schematic of Liquid Waste Stream Pipeline Routing Network in the 200 Areas.

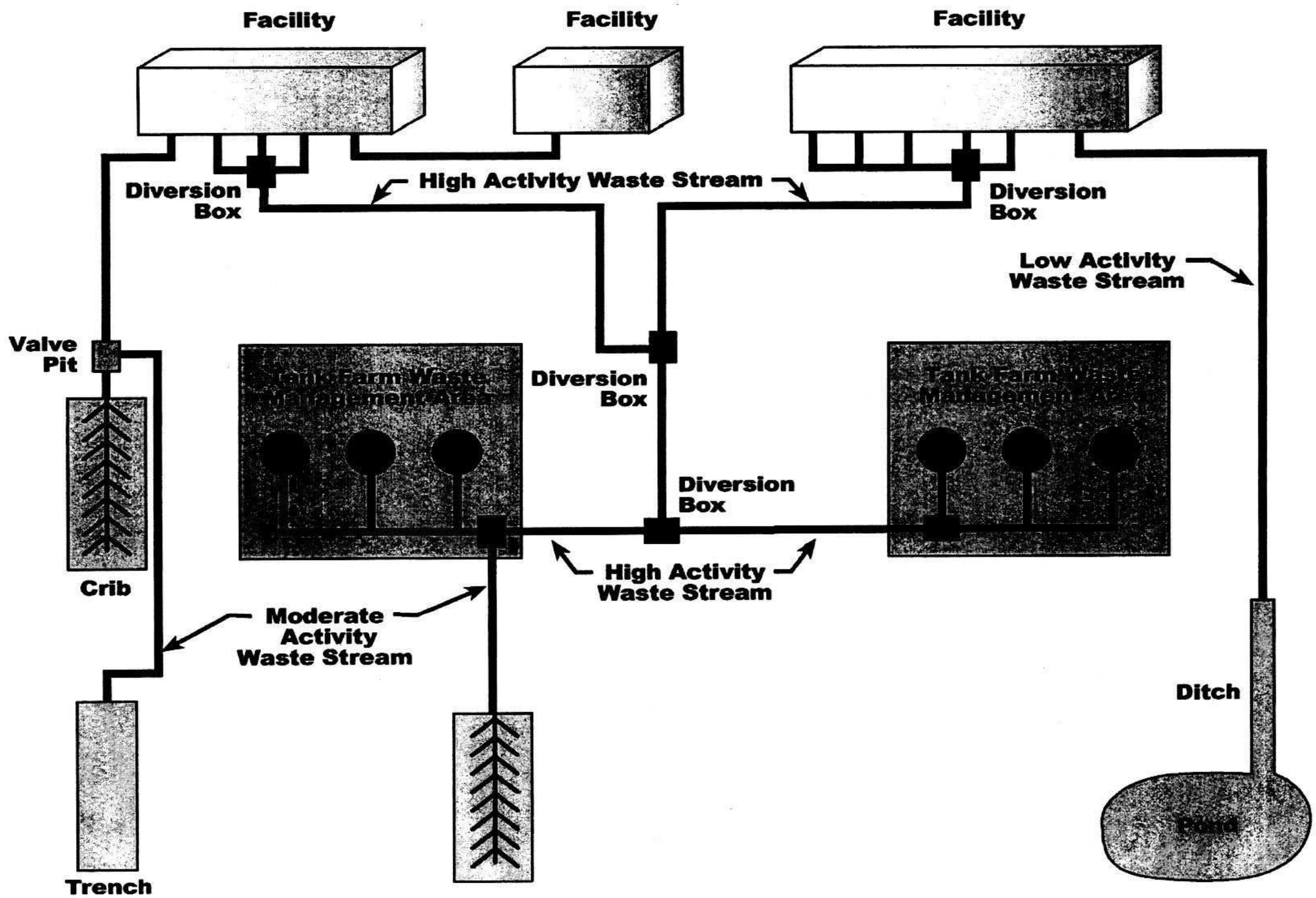


Figure 2-8. Generalized Cross-Sectional View of Direct-Buried Pipelines.

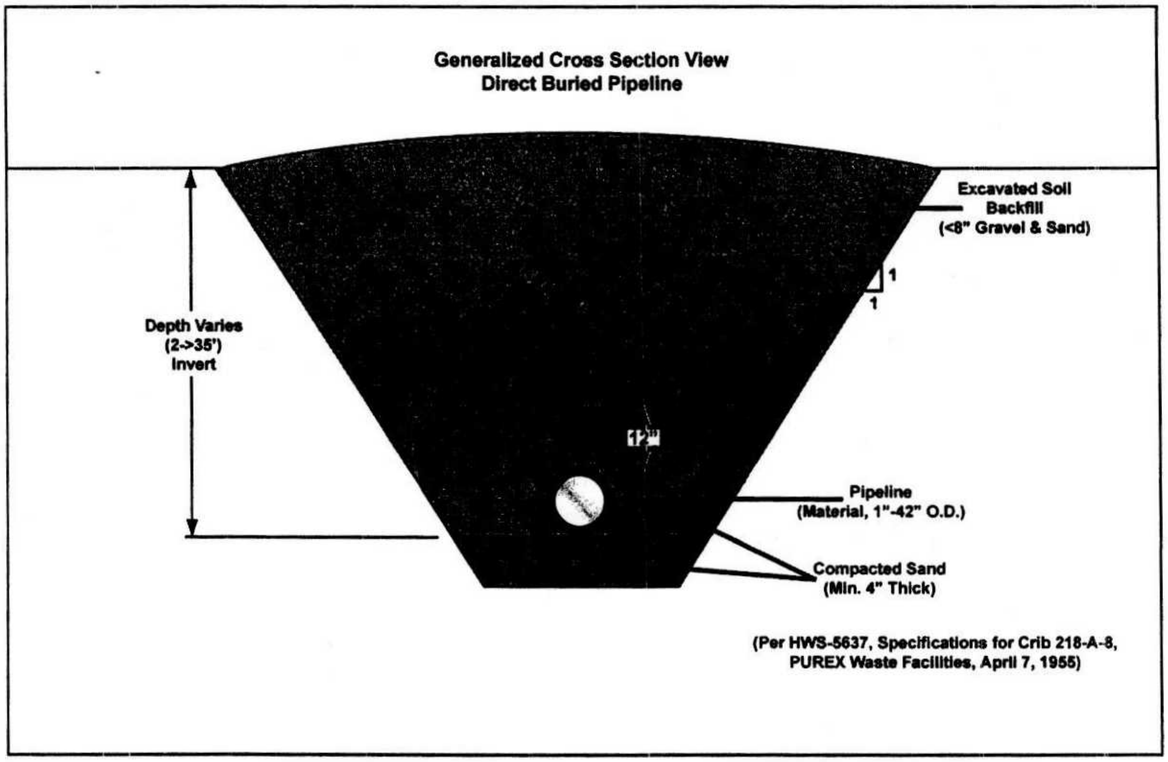


Figure 2-9. Generalized Cross-Sectional View of Encased Multiple Pipelines.

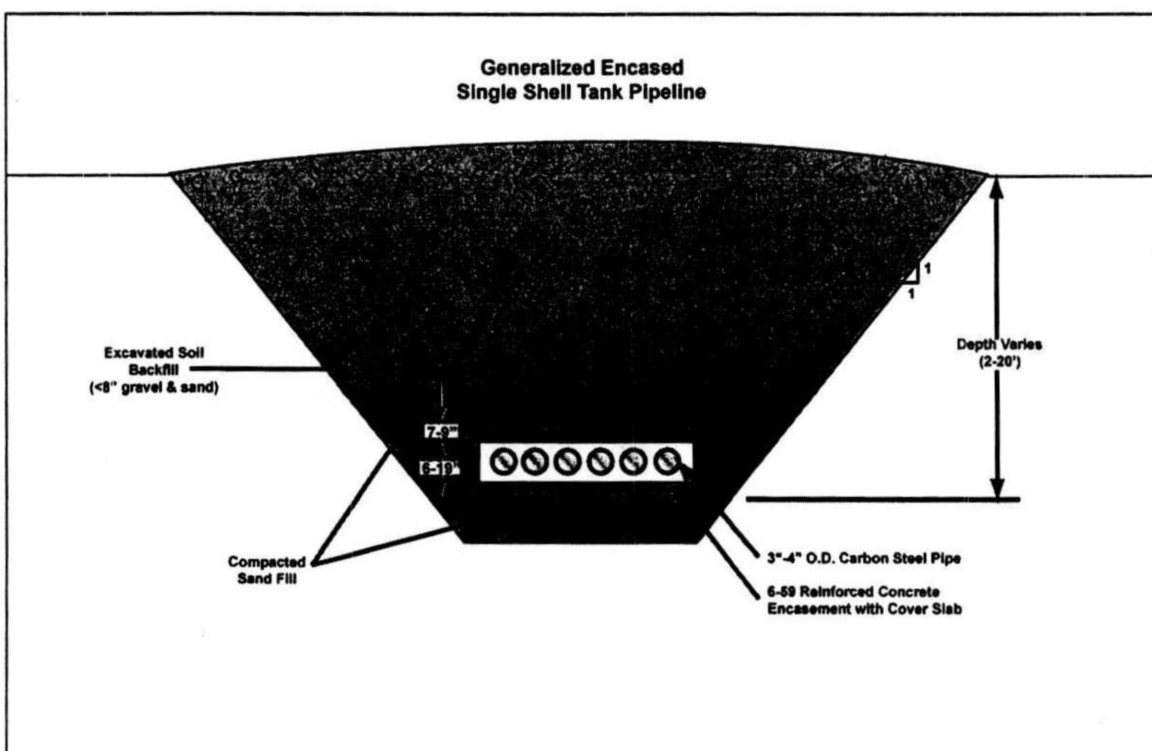


Figure 2-10. Generalized Configuration of a Typical Diversion Box and Catch Tank.

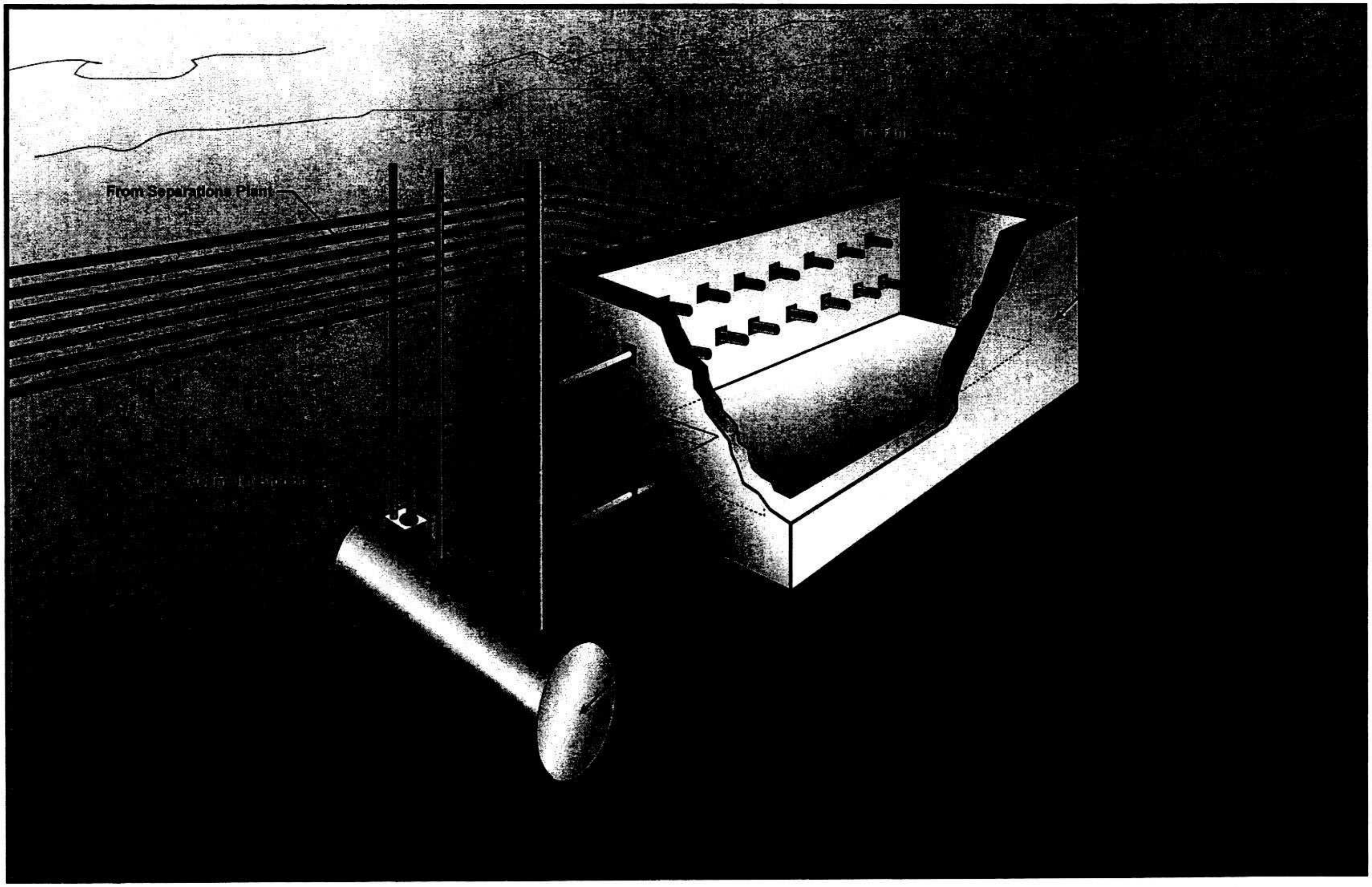


Figure 2-11. Hot Semi-Works Plan View.

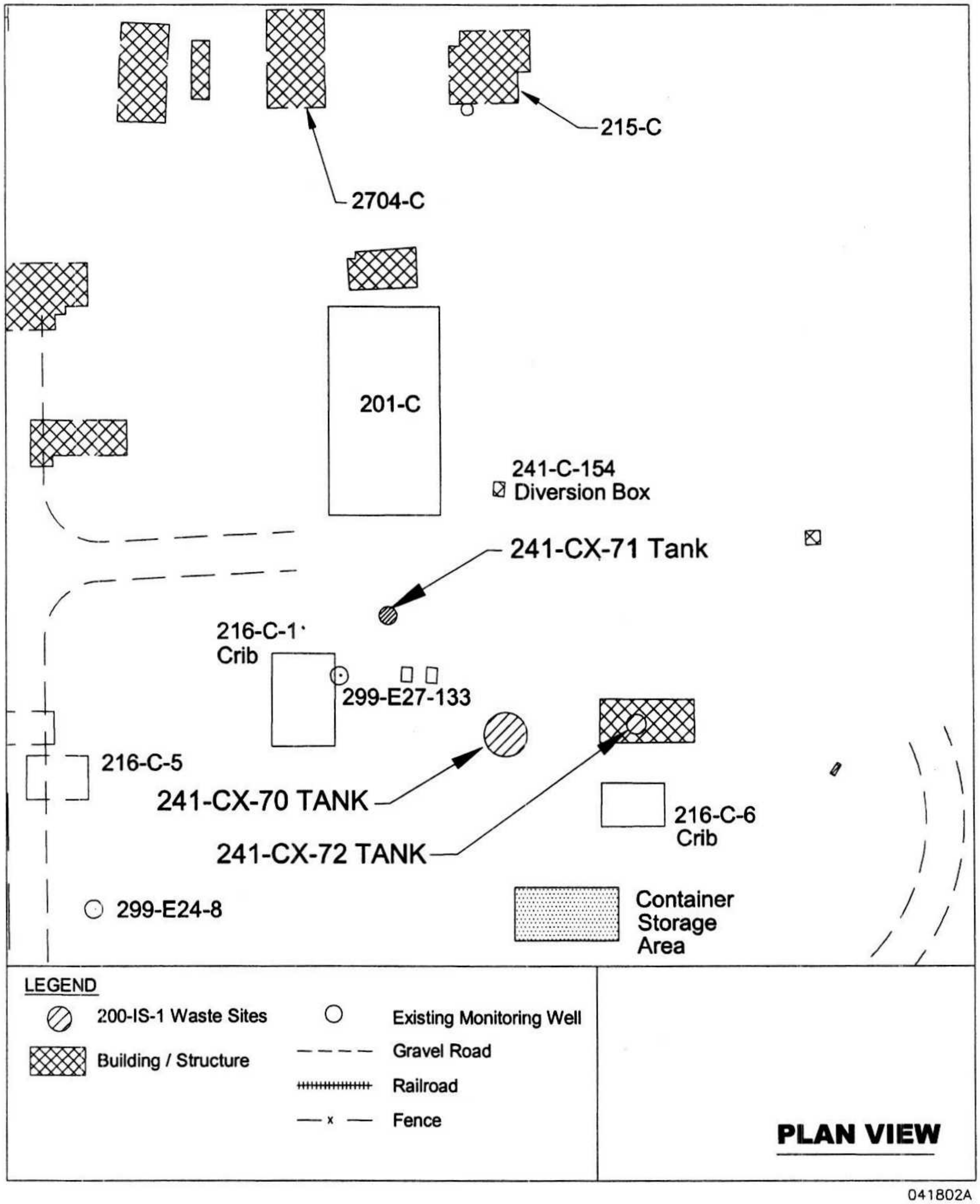


Figure 2-12. 241-CX-70 Storage Tank Construction Diagram.

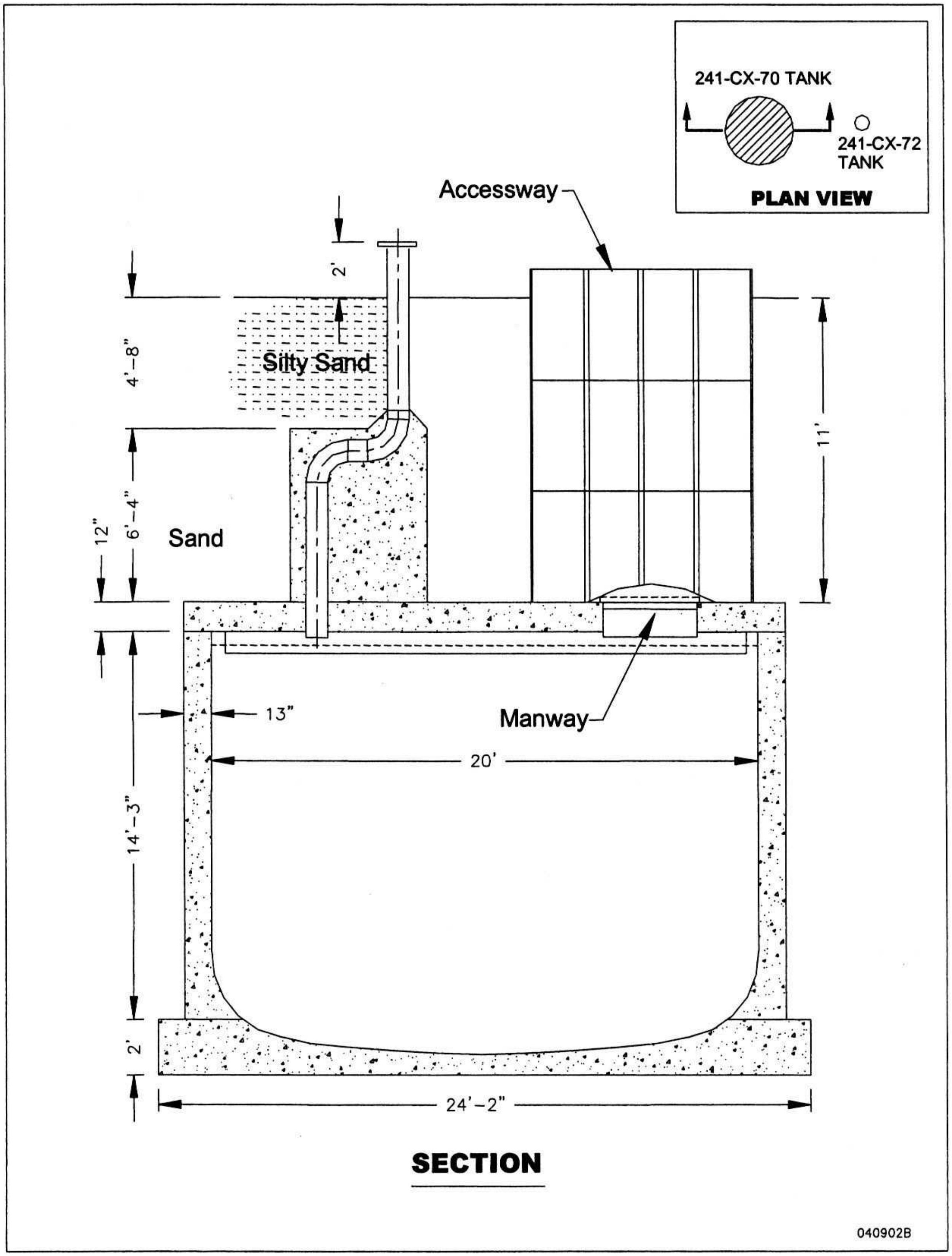


Figure 2-13. 241-CX-71 Storage Tank Construction Diagram.

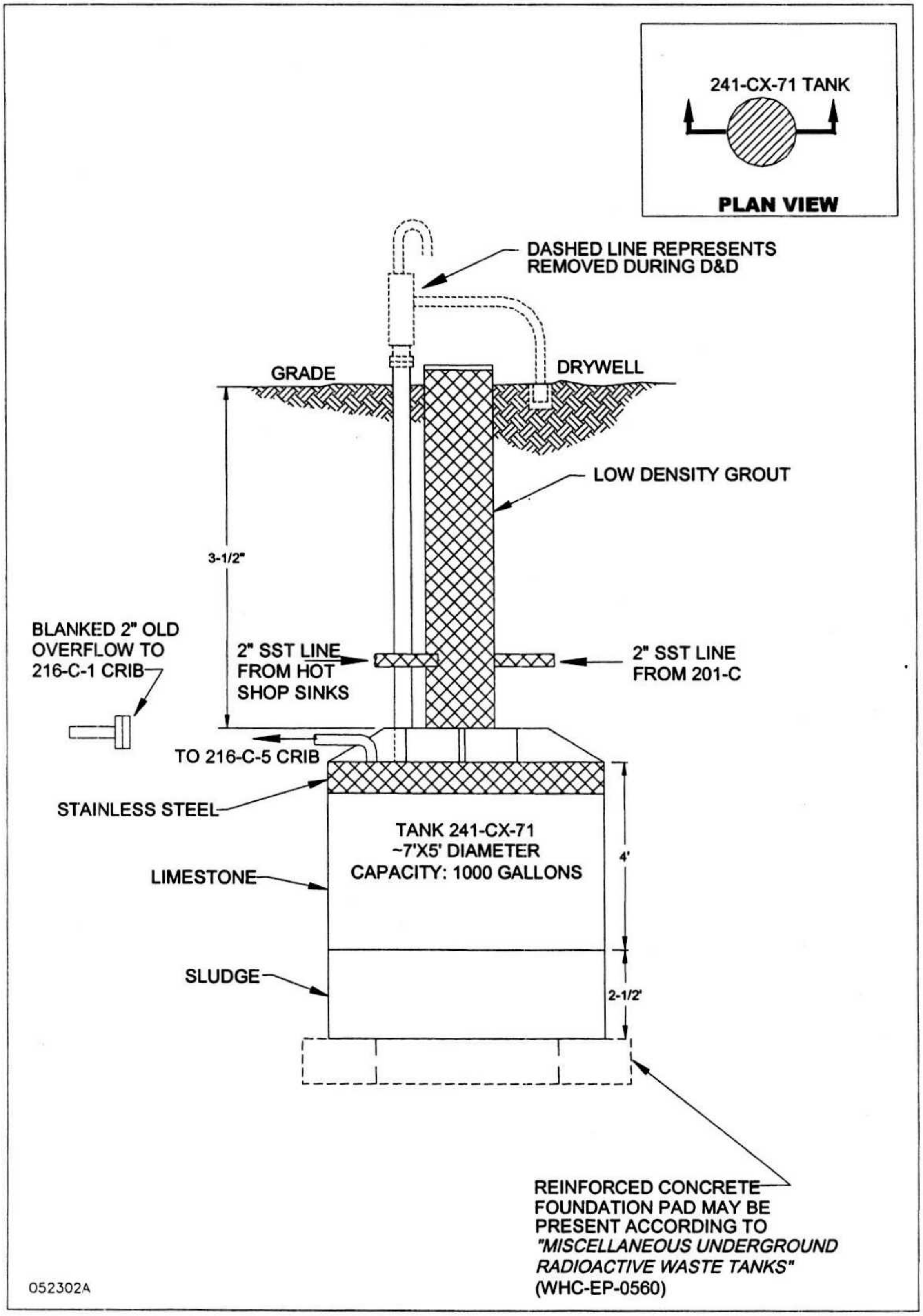


Figure 2-14. 241-CX-72 Storage Tank Construction Diagram.

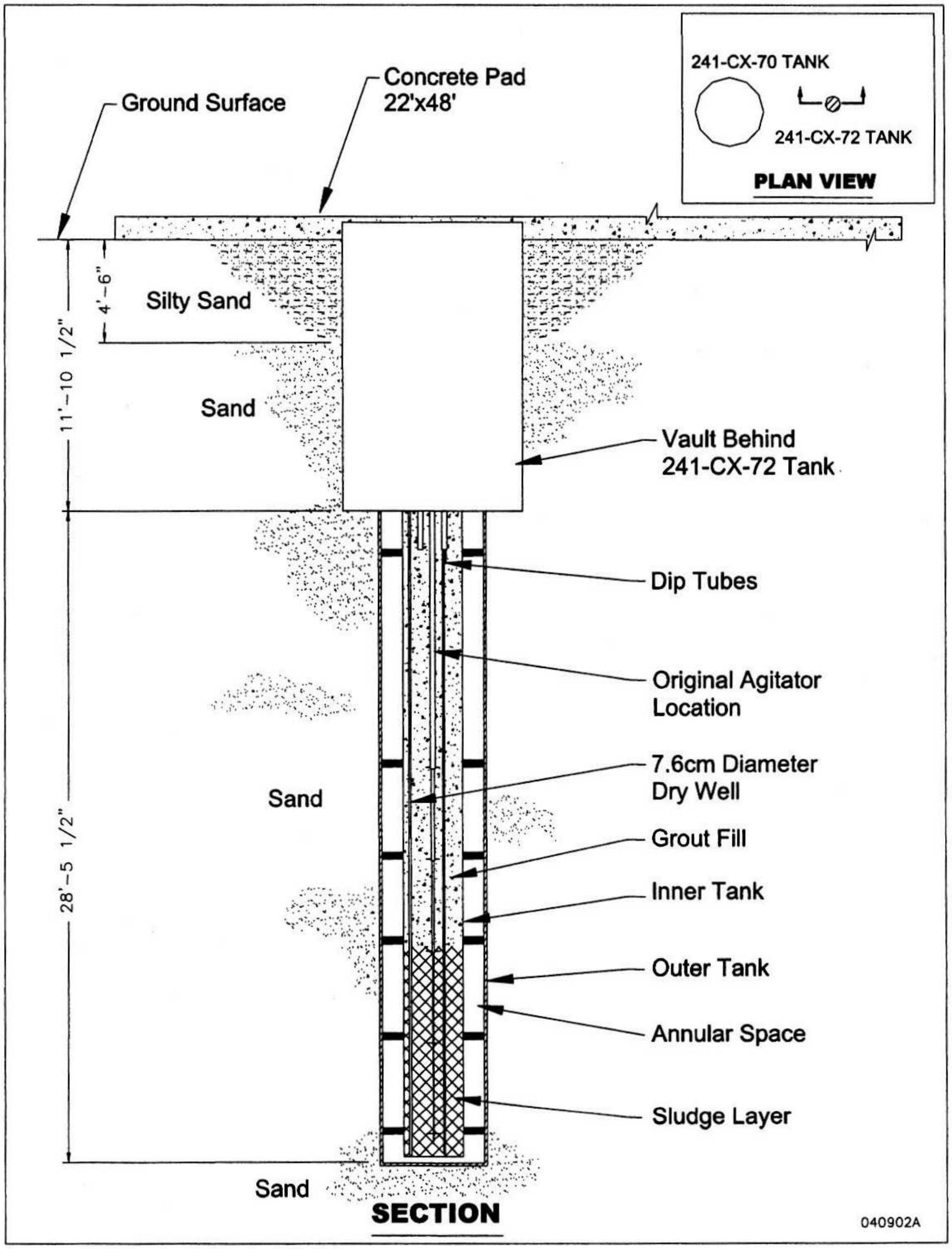


Figure 2-15. 276-S-141 and 276-S-142 Storage Tank Construction Diagram.

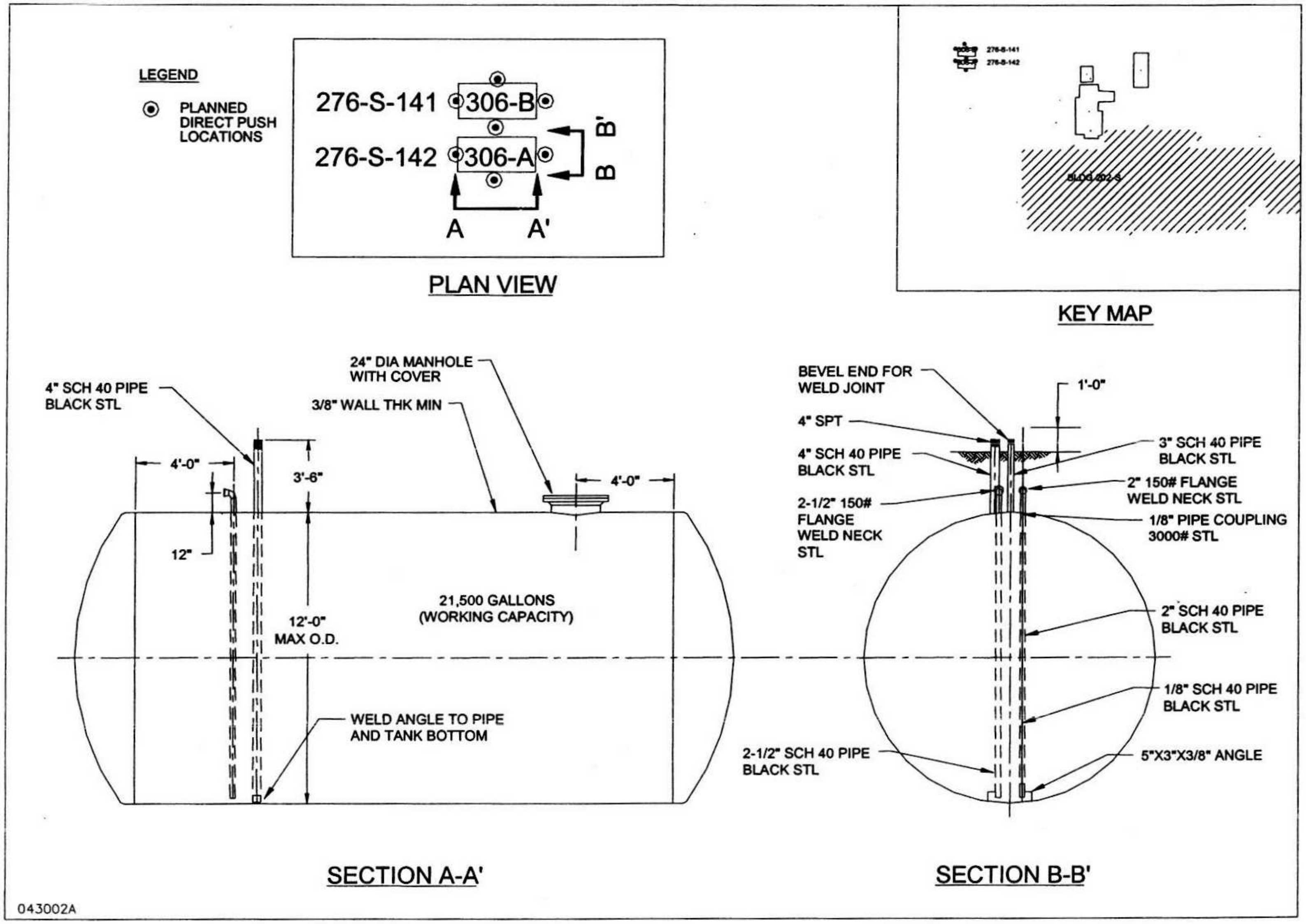
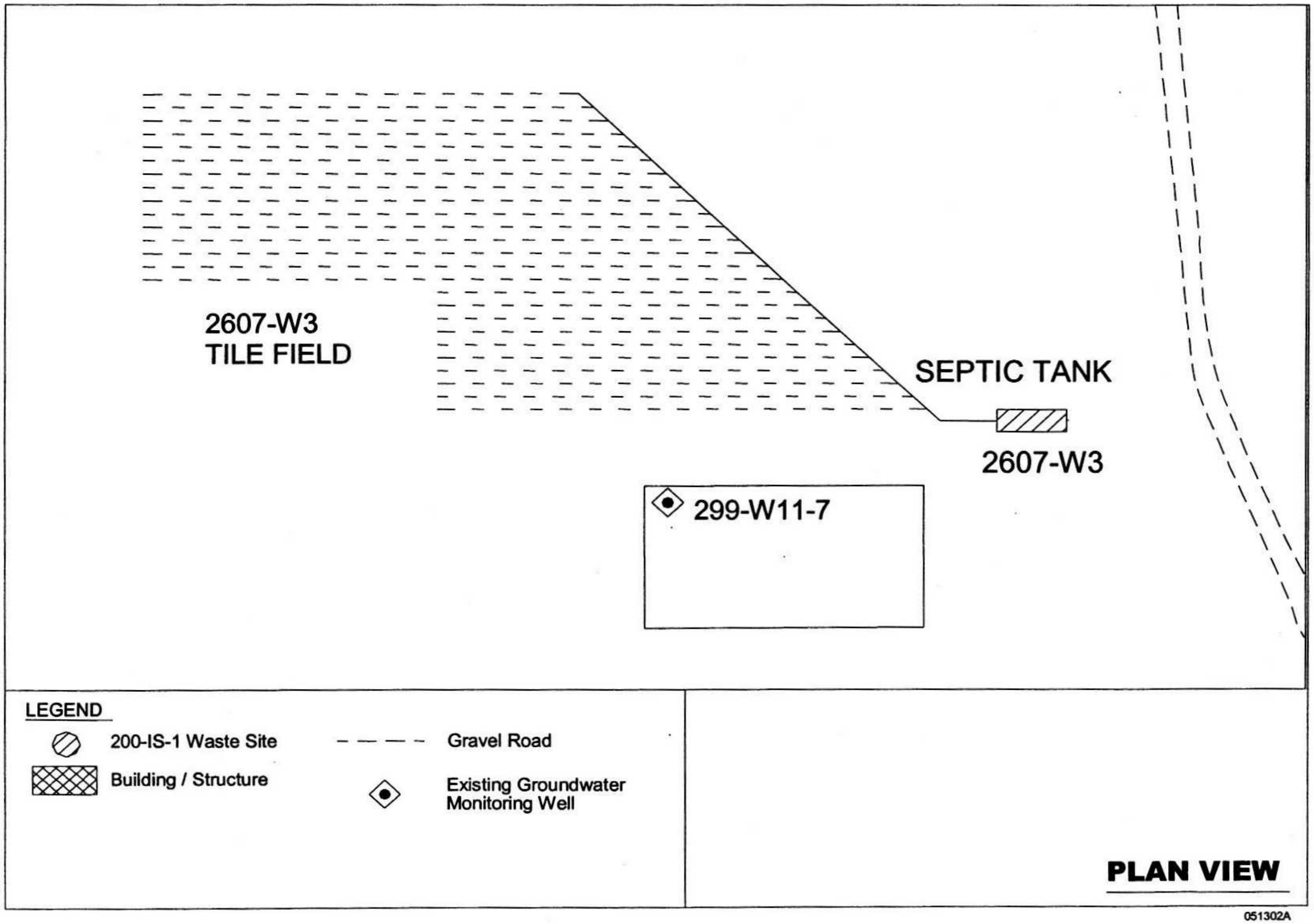


Figure 2-16. 2607-W3 Septic Tank Construction Diagram.



3.0 INITIAL EVALUATION 200-IS-1 AND 20-ST-1 WASTE SITES

This section presents the results of previous characterization efforts conducted at the 200-IS-1 OU waste sites and the 200-ST-1 OU representative waste site. This section also presents information on contaminant inventory, effluent volume, and available soil and groundwater data. Sections 3.3 and 3.4 contain information that will be used for portions of the RCRA TSD closure plan. Section 3.3 describes the nature and extent of contamination that corresponds to the closure plan facility description. Section 3.4 presents the current RCRA interim status groundwater monitoring requirements.

3.1 KNOWN AND SUSPECTED CONTAMINATION

The estimated composition of the primary radionuclides and nonradiological constituents that potentially may have been released to the vadose zone at waste sites in the 200-IS-1 OU was obtained from numerous sources. Process waste streams generated at the 200 Area facilities and handled by the structures associated with the 200-IS-1 and 200-ST-1 waste sites are discussed in Section 2.2. Additional sources of information used for the waste source and inventory discussion presented in this section included the following:

- WIDS
- Aggregate area management study reports for the 200 Areas:
  - DOE/RL-92-05, Rev. 0, *B Plant Source Aggregate Area Management Study Report*
  - DOE/RL-91-52, Rev. 0, *U Plant Source Aggregate Area Management Study Report*
  - DOE/RL-91-60, Rev. 0, *S Plant Aggregate Area Management Study Report*
  - DOE/RL-92-04, Rev. 0, *PUREX Plant Source Aggregate Area Management Study Report*
  - DOE/RL-92-18, 1993, Rev. 0, *Semi-Works Plant Source Aggregate Area Management Study Report*
- DOE/RL-98-28, Rev. 0, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*
- DOE/RL-96-81, Rev. 0, *Waste Site Grouping Report for 200 Areas Soil Investigations*.

The radionuclide and nonradiological waste inventory transferred or stored during active operations associated with these 200-IS-1 OU was not fully documented in historical records. However, rough-order-of-magnitude estimates are documented in DOE/RL-98-28 and WIDS based on existing waste stream analyses. The inventory information, where available, indicates waste stream compositions consisting predominantly of cesium-137, strontium-90, uranium, plutonium, and nitrate (DOE/RL-96-81).

3.2 ENVIRONMENTAL MONITORING

Current efforts at the Hanford Site focus on environmental cleanup. Before the recent cleanup efforts began, monitoring was performed across the Hanford Site to measure and evaluate long-term trends in the environmental accumulation of radioactive contamination. Risks associated with unacceptable levels of contamination were typically addressed by stabilizing the waste sites with soil, concrete, and/or gravel backfill to minimize impact on human health and the environment.

Typically, the accumulation of radioactivity at disposal sites was evaluated through gathering and analyzing soil samples. These samples generally were collected less than 0.3 m (1 ft) directly below the bottom of the receiving sites. Samples were collected annually, however, the number of samples collected was limited, and sample locations were not always documented. Therefore, little or no information is typically available to evaluate the lateral and vertical extent of contamination in the vadose zone during active periods of discharge. Analyses for nonradioactive constituents were usually not conducted. Scintillation logging was commonly performed in boreholes adjacent to waste sites. The logs were used to determine the extent of radiological contamination in the subsurface; however, these logs are not quantitative and only generally indicate the presence of radiological contamination. Groundwater is monitored for some constituents at these sites based on RCRA requirements and the objectives of the Hanford Sitewide groundwater monitoring program.

Currently, environmental monitoring at the Hanford Site consists of effluent monitoring, groundwater and vadose zone monitoring, and environmental surveillance. The environmental surveillance is conducted for the following media:

- Air
- Surface water and sediments
- Drinking water
- Farm and farm products
- Soil and vegetation
- External radiation.

Air, external radiation, soil, and vegetation are evaluated routinely in the 200 Areas as part of the Hanford Site near-facility and environmental monitoring programs. Results of the near-facility and environmental monitoring programs are presented in annual reports. The annual reports (e.g., PNNL-13230, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1999*, and PNNL-13316, *Hanford Site Environmental Report for Calendar Year 1999*) contain data most applicable to the 200-IS-1 and 200-ST-1 OUs. PNNL-13230 focuses on monitoring activities near facilities that have potential to or have discharged, stored, or disposed radioactive or hazardous materials, including those facilities within the 200 Areas. PNNL-13316 covers the entire Hanford Site, including those areas not associated with operations (e.g., the 600 Area). This annual report examines the resources associated with the Hanford Site, including the media listed in the previous paragraph, and groundwater. Results of monitoring efforts pertinent to the 200-IS-1 and 200-ST-1 OU waste sites are presented in Section 3.3 and Section 3.4. The potential impacts of 200-IS-1 and 200-ST-1 OU waste site contamination on human health and the environment are discussed in Section 3.5.

Groundwater also is routinely monitored Sitewide. More than 600 monitoring wells are sampled annually to characterize groundwater flow; groundwater contamination by metals, radionuclides, and nonradiological constituents; and the extent of contamination. Contaminated groundwater, ingestion risk, and dose also are assessed. Results of groundwater monitoring and remediation are presented in annual reports (e.g., PNNL-13788, *Hanford Site Groundwater Monitoring for Fiscal Year 2001*). The groundwater monitoring reports also summarize vadose zone characterization activities conducted on the Hanford Site as part of other projects.

3.3 NATURE AND EXTENT OF CONTAMINATION

The following sections describe the current assessment of nature and extent of contamination at 200-IS-1 pipelines, diversion boxes, and associated waste sites; the 200-IS-1 RCRA tank TSD units; and the 200-ST-1 representative waste site.

3.3.1 241-CX-70 Tank

3.3.1.1 Sources of Waste Contributions

The 201-C Building, A cell, was reported as discharging waste to storage tank 241-CX-70. According to Figure 2 of HW-31373, *Hot Semi-Works REDOX Studies*, and Hanford Site drawings (i.e., H-2-4093, *Hot Semi-Works Process Piping Plan A Cell*; H-2-4105, *Hot Semi-Works Engineering Flow Sketch*; and H-2-4335, *Hot Semi-Works Waste Line Bldg. 201-C to TK-70*), the following equipment discharged waste from A cell to tank 241-CX-70: steam transfer jets and piping that connected the scrubber, oxidizer, dissolver, feed makeup, and waste receiver tanks, as well as the centrifuge to the waste concentrator tank.

3.3.1.2 Maximum Volume of Waste Managed

According to drawing HW-52860, *Standby Status Report for Hot Semi-Works Facility*, the total estimated effluent volume received was 95,000 L (25,000 gal) of non-neutralized REDOX waste. However, in May 1974, the material-level measurements indicated that 14 ft of liquid and sludge remained in the tank (AR00227, *Disposition and Isolation of Tanks 270-E-1, 270-W, 241-CX-70, 241-CX-71, and 241-CX-72*). Based on the 1974 material-level reported, tank 241-CX-70 contained approximately 11,000 L (2,900 gal) more volume than it reportedly received in 1957, for a total of 106,000 L (28,000 gal).

3.3.1.3 Historical Sampling and Analysis

Limited information is available to evaluate the nature and extent of potential contamination beneath tank 241-CX-70. Well 299-E27-5, located approximately 77 m (253 ft) east of tank 241-CX-70, was drilled in September 1962 to a depth of 102 m (335 ft). No information was available regarding soil samples or radiological surveys in the vadose zone. Groundwater levels for March 2002 were reported at 87 m (284 ft) bgs. Sample data for well 299-E27-5, last reported in 1987, showed strontium and uranium concentrations ranging from 0.01 to 2.04 pCi/L. In 1967, strontium levels ranged from 2.4 to 28 pCi/L.

The amount of effluent discharged to the soil column is unknown, but comparing liquid-level data from July 1974 to the data from an unknown later date indicated that the tank had not leaked. The tank was designed and constructed specifically for storing high-level process waste in support of the Hot Semi-Works processes. In April 1976, analysis of the remaining sludge in tank 241-CX-70 reported that fission products totaled approximately 4,300 Ci of strontium-90, 870 Ci of cesium-137, and 3.4 Ci of TRU (SD-WM-SAR-003, *Safety Analysis Report for the Decontamination and Decommissioning of the Strontium Semi-Works Complex*).

Sludge removal activities began in the summer of 1987 with the construction of a sluicing/ pumping system. Grab samples collected on August 17, 1988, showed alpha readings ranging from 390 to 690 nCi/g of filtered solids. The TRU content of the sludge was approximately 50 nCi/g, with a pH of 13 in the liquid phase. Halogenated hydrocarbons were recorded at

0.0009 weight percent. In addition, as reported in 12712-PCL88-019, *Analysis of Sludge Samples from Hot Semi-Works Tank CX-70*, qualitative identification classified the organics as aliphatic amines or possibly aliphatic alcohol. The waste was removed later, and the tank is now empty.

Because the tank's integrity seems to be intact, an assumption for the conceptual model focused on the potential leaks associated with the pipe connections above the tank. Although leakage has been reported from the pipe connections, the conceptual model conservatively assumes that 0.1% of the total waste transferred (i.e., 95 L [25 gal]) to the tank through the associated piping could potentially have leaked. Assuming this potentially released volume is in the soil adjacent to and beneath the tank, the entire volume is capable of being retained by the soil within 9 m (30 ft) of the ground surface. Based on these assumptions, wastewater and mobile contaminants most likely have not affected groundwater because the soil column pore volume is greater than the estimated liquid release.

The status of groundwater contamination near tank 241-CX-70 is described in the Hanford Site groundwater monitoring report (PNNL-13788). Reported groundwater concentrations of iodine-129 exceed groundwater protection standards beneath the waste site. Groundwater plumes in the 200 East Area are shown in Figures 3-1 and 3-2. Groundwater wells in the area are sparse and mainly cross-gradient (east or west) of the site and, therefore, do not provide useful analytical information. One downgradient well, 299-E27-1, was reviewed for groundwater concentrations of uranium and strontium. The records compared to the results from well 299-E27-5 were generally equivalent and ranged from 0.259 to 2.04 pCi/L.

3.3.2 241-CX-71 Tank

3.3.2.1 Sources of Waste Contributions

The 201-C Building hot shop routed condensate, coil, and condenser cooling waters containing low-level radioactivity waste from the hot sinks to tank 241-CX-71 before discharging the waste to the 216-C-1 and 216-C-5 Cribs according to WHC-SD-DD-TI-040, *Tank 241-CX-72 Preliminary Waste Characterization*, and drawings H-2-4010, *Strontium Semi-Works &Vicinity Outside Lines Key Map*; H-2-4420, *Plot Plan Hot Semi-Works Waste Self-Concentrator*; and H-2-4535, *Plot Plan Hot Semi-Works Waste Self Concentrator.*

3.3.2.2 Maximum Volume of Waste Managed

The total estimated effluent volume received was approximately 33 million L (8.8 million gal) of waste (AR00227).

3.3.2.3 Historical Sampling and Analysis

Limited information is available to evaluate the nature and extent of potential contamination beneath tank 241-CX-71. Well 299-E27-5, drilled in September 1962, is located about 314 m (1,000 ft) to the east. The maximum depth of the boring was 102 m (335 ft). No information was available regarding soil samples or radiological surveys in the vadose zone. Groundwater levels for March 2002 were reported at 87 m (284 ft) bgs. Sample data for well 299-E27-5, last reported in 1987, showed strontium and uranium concentrations ranging from 0.0107 pCi/L to 2.04 pCi/L. In 1967, strontium levels ranged from 2.4 to 28 pCi/L.

The effluent volume discharged at this site to the soil column is unknown and depends on the integrity of the stainless-steel tank during its year of operation. Tank 241-CX-71 was designed and constructed for the neutralization of acidic low-level radioactive waste. As reported in WHC-SD-DD-SAD-001, *Safety Evaluation for Interim Waste Management Activities in Tank 241-CX-70, Tank 241-CX-71, and 241-CX-72*, it is estimated that waste discharged to tank 241-CX-71 contained 2.46E-08 g/L plutonium; 43,000 nCi/L strontium-89/90; and 1,600 nCi/L cesium-137. The maximum inventory was estimated at 6 Ci TRU and 6,000 Ci beta.

In October 1990, gas, liquid, and sludge samples were collected from tank 241-CX-71. Extremely low concentrations of methyl ethyl ketone, xylene, and toluene ranging from 7 to 54 parts per billion (ppb) were measured. Cyanide was measured in the sludge at 21 parts per million (ppm).

The stainless-steel tank was in operation for less than 3 years. An assumption for the conceptual model focused on the potential leaks associated with the pipe connections above the tank. Because no leaks from the pipe connections were documented, the conceptual model assumes that 0.1 gal/hr (i.e., potentially 8,300 L [2,200 gal]) could have leaked over the timeframe that the neutralizing tank and associated piping were in service. Assuming that this volume is within the soils adjacent to and beneath the tank, the entire volume is capable of being retained by the soils within 15 m (50 ft) of the ground surface. The soil column pore volume is greater than the estimated liquid release; consequently, wastewater and mobile contaminants likely have not affected the groundwater.

The status of groundwater contamination near tank 241-CX-71 is described in PNNL-13788. The report indicates that groundwater concentrations of iodine-129 exceed groundwater protection standards beneath the site. Groundwater plumes in the 200 East Area are shown in Figures 3-1 and 3-2. Groundwater wells in the area are sparse and mainly cross-gradient and, therefore, do not provide useful analytical information. Uranium and strontium records for well 299-E27-5 indicate concentrations ranging from 0.26 to 2.04 pCi/L. This well is located downgradient of tank 241-CX-71. Based on the review of the operational history, these plumes are not the result of tank 241-CX-71 operation.

3.3.3 241-CX-72 Tank

3.3.3.1 Sources of Waste Contributions

According to WHC-SD-DD-TI-040 and drawings H-2-4093, H-2-4420 and H-2-4535, only A and C cells of the 201-C Building discharged waste to storage tank 241-CX-72.

3.3.3.2 Maximum Volume of Waste Managed

According to drawing HW-52860, the estimated effluent volume received was 8,700 L (2,300 gal) of liquid waste.

3.3.3.3 Historical Sampling and Analysis

Limited information is available to evaluate the nature and extent of potential contamination beneath tank 241-CX-72. The nearest groundwater well is 299-E27-5, located about 57.3 m (188 ft) to the east of the tank. The well was drilled in September 1962 to a depth of 102 m (335 ft). No information was available regarding soil samples or radiological surveys in the vadose zone. Groundwater levels for March 2002 were reported at 86.6 m (284 ft) bgs. A search of the Hanford Environmental Information System (HEIS) database for strontium and uranium for well 299-E27-5 showed that the constituents were last reported for 1987. Concentrations ranged from 0.0107 to 2.04 pCi/L. Strontium levels reported for 1967 ranged from 2.4 to 28 pCi/L.

The effluent volume discharged at this site to the soil column is unknown. The probability of contamination spread from this site is estimated to be zero to very low. The tank received only 8,700 L (2,300 gal) of liquid waste (HW-52860). In addition, material-level measurements indicated that 74 in. of sludge and 1 in. of liquid were present in the tank in July 1974 and 76 in. of sludge and 1 in. of liquid were present in November 1974. Tank 241-SX-72 was designed and constructed specifically for the concentration and terminal storage of waste from the pilot PUREX studies. In letter AR00227, sampling results for a clear, light-brown solution with a pH of 9.5 and a trace of solids were reported as follows:

- Total plutonium: 1.13×10^{-8} g/gal
- Total uranium: 2.43×10^{-3} g/gal
- Strontium-89/90: 4.33 mCi/g
- Cesium-137: analysis performed, but not detected.

In 1988, nondestructive assays were performed to evaluate the radiological content of tank 241-CX-72. Three smears were collected from an agitator rod that was inadvertently removed from the tank. WHC-SD-CP-TI-148, *Radiological Evaluation of Hot Semi-Works Tank 241-CX-72*, reported alpha activity between 2,000 and 8,000 disintegrations per minute (dpm), gamma activity between 2.64E3+3 and 5.81E3+3 pCi, and a beta-to-gamma ratio of 25:1. The report concluded that the residual waste material contains 150 to 200 g of plutonium. WHC-SD-DD-TI-051, *An Estimation of the Radionuclide Content of Tank 241-CX-72*, estimated that between 9,000 and 10,000 Ci of cesium-137 would be present based on data presented in WHC-SD-CP-TI-148. The sludge was never removed from the tank.

Because the tank's integrity seems to be intact, an assumption for the conceptual model focused on the potential leaks associated with the pipe connections above the tank. Although no information about the volume of leakage from the pipe connections is available, the conceptual model assumes that 1%, or 87 L (23 gal), of the waste transferred to the tank through the associated piping could have leaked. Assuming that this potential was realized, the released volume is within the soils adjacent to the tank, and the entire volume can be retained by the soils within 4.6 m (15 ft) of ground surface. Thus, wastewater and mobile contaminants have most likely not affected groundwater because the soil column pore volume is greater than the estimated liquid release.

The status of groundwater contamination near tank 241-CX-72 is described in PNNL-13788. The report indicates that groundwater concentrations of iodine-129 exceed groundwater protection standards beneath the site. Groundwater plumes in the 200 East Area are shown in Figures 3-1 and 3-2. Groundwater wells in the area are sparse and mainly cross-gradient (east or west) of the site and, therefore, do not provide useful analytical information. Downgradient well 299-E27-1 was reviewed for groundwater concentrations of uranium and strontium using HEIS. The records were generally equivalent to those for well 299-E27-5 and ranged from 0.259 to 2.04 pCi/L. These plumes are not expected to be associated with tank operations.

3.3.4 Hexone Storage and Treatment Facility

Located in the southeast corner of the 200 West Area, the HSTF consists of two 91,200-L (24,000-gal) tanks (DOE/RL-88-21, *Dangerous Waste Permit Application*) used to store reagent-grade hexone for use in the REDOX Plant. These tanks received waste during decontamination of REDOX Plant.

3.3.4.1 Tank 276-S-141

3.3.4.1.1 Sources of Waste Contribution. Essentially pure hexone waste was transferred to storage tank 276-S-141 from the 276 Building (located to the south of the tank), as described in Section 2.0 and shown on Hanford Site drawing H-2-5304, *276 Organic-Solvent Make-Up Storage Piping.*

3.3.4.1.2 Maximum Volume of Waste Managed. The estimated volume of hexone received by tank 276-S-141 was 605,600 L (160,000 gal). This estimate is based on CCN 100786, *276-S-141/142 Hexone Storage Tank Sludge Sampling Results,* which reported that 76,000 L (20,000 gal) of essentially pure hexone was discharged annually to tank 276-S-141.

3.3.4.1.3 Historical Sampling and Analysis. Limited information is available to evaluate the nature and extent of potential contamination beneath tank 276-S-141. Well 299-W22-14, drilled in March 1956, is located approximately 38 m (125 ft) northwest of the hexone tanks and is 104 m (342 ft) deep. Information about soil samples and radiological surveys in the vadose zone was not available. The groundwater level in well 299-W22-20 for March 2002 was reported as 134.62 m (441.37 ft). Strontium levels were monitored in this well from January 1956 through February 1961, with concentrations ranging from 55 to 7,000 pCi/L; uranium was monitored from August 1956 to December 1957, with concentrations ranging from 1.5 to 24 pCi/L.

The probability of contamination spread from a tank leak is estimated to be zero to very low. In April 1976, ARH-CD-639, *Integrity of Tank 276-S-141 and 276-S-142,* reported the integrity of the tank as good. The tank's average wall thickness was 0.83 to 0.92 cm (0.327 to 0.363 in.); the tank was constructed specifically to store clean hexone.

The tank was sampled twice and the results were reported in ARH-CD-685, *Characterization of the Contents of Organic Waste Storage Tanks 276-S-141 and 276-S-142*, and WHC-SP-0350, *Hexone Remediation Demonstration Plan for Tanks 276-S-141 and 276-S-142.* The 1976 analytical work characterized the material in both tanks and included preliminary distillation tests (ARH-CD-685). The 1988 work obtained fully representative concentrations with the goal of determining a practical means for treating and disposing the waste (WHC-SP-0350). These results are consistent with the operator-based knowledge of process information. The analytical results and historical knowledge are summarized from DOE/RL-92-40.

Tank 276-S-141 has a capacity of 76,000 L (20,000 gal) and contained the following:

- Hexone: 98.4%
- Water : 1.6%
- Total alpha: <31 pCi/L

- Total beta: 4,910 pCi/L
- Iodine-129: 5,460 pCi/L
- Tritium: 7,470,000 pCi/L (estimate).

Pumpable liquids were removed from the tank in 1991, after which it contained approximately 950 L (250 gal) of residual, tar-like sludge. The sludge was collected and analyzed in March 2001. The principal chemical components of the sludge were NPH, TBP, iron oxide, and hexone. The principal radionuclides were americium-141, plutonium isotopes, strontium-90, and cesium-137 (CCN 100786).

Because the tank's integrity seems to be intact, an assumption for the conceptual model focused on the potential leaks associated with the pipe connections above the tank. Although no information about leak volumes from the pipe connections is available, the conceptual model assumes that 0.05 gal/hr, or 4,800 L (1,300 gal), could have leaked over the timeframe that the tank and associated piping were in service. Assuming that this potentially released volume is within the soils adjacent to and beneath the tank, the entire volume can be retained by the soils within 6.7 m (22 ft) of the ground surface. Thus, wastewater and mobile contaminants most likely have not affected the groundwater.

The status of groundwater contamination in the vicinity of tank 276-S-141 is described in PNNL-13788. The report indicates that groundwater concentrations of carbon tetrachloride, iodine-129, and uranium exceed groundwater protection standards beneath the waste site. Groundwater plumes in the 200 West Area are shown in Figures 3-1 and 3-2. However, based on process history, these plumes are not presumed to be associated with these tanks. Few groundwater wells are in the area and are located west, southeast, and east-northeast of the tank; however, because of their distance from the tank and the other surrounding waste sites, they do not provide useful information about this site.

3.3.4.2 Tank 276-S-142

3.3.4.2.1 Sources of Waste Contributions. According to drawing H-2-5304, storage tank 276-S-142 was originally used to store reagent-grade hexone from the 276 Building, located to the south of the tank. The tank was later was used to store NPH and TBP during a one-time separations activity involving fuel from the Shippingport reactor.

3.3.4.2.2 Maximum Volume of Waste Managed. The total estimated effluent volume received by 276-S-142 was 980,000 L (256,000 gal) of mainly reagent-grade hexone, as described above. This volume is based on the information in DOE/RL-96-82, which reported that 61,000 L (16,000 gal) of hexone waste was discharged annually to tank 276-S-142.

3.3.4.2.3 Historical Sampling and Analysis. Limited information is available to evaluate the nature and extent of potential contamination beneath tank 276-S-142. Well 299-W22-14, drilled in March 1956, is located approximately 44 m (145 ft) to the northwest and is 104 m (342 ft) deep. No information was available about soil samples or radiological surveys in the vadose zone. The groundwater elevation in well 299-W22-14 is approximately 134.6 m (441.3 ft). Strontium was monitored from January 1956 through February 1961, with concentrations ranging from 55 to 7,000 pCi/L. Uranium was monitored from August 1956 to December 1957, with concentrations ranging from 1.5 to 24 pCi/L.

The probability of contamination spread from a tank leak is estimated to be zero to very low. ARH-CD-639 stated that the integrity of the tank is good. The tank's average wall thickness was 0.89 to 0.91 cm (0.350 to 0.357 in.), and the tank was designed and constructed specifically to store clean hexone. The tank contents were sampled twice. The 1976 analytical work characterized the material in both tanks and included preliminary distillation tests (ARH-CD-685). The 1988 work obtained fully representative concentrations with the goal of determining a practical means for treating and disposing of the waste (WHC-SP-0350). The results are consistent with the operator knowledge of process information. The analytical results and historical knowledge are summarized from DOE/RL-92-40. Tank 276-S-142 has a capacity of 76,000 L (20,000 gal) and contained the following:

- 7,600 L (2,000 gal) of water
- 53,000 L (14,000 gal) of the following mixture:
  - 60% hexone
  - 25.2% NPH
  - 12.6% TBP and 1.7% water
  - 380 L (100 gal) tarry sludge resting on the base of the tank.

The radionuclide inventory is as follows:

- Total alpha: 2,070,000 pCi/L
- Total beta: 871,000 pCi/L
- Iodine-129: 34,500 pCi/L
- Tritium: 3,162,000 pCi/L (estimated).

After the pumpable liquids were removed from the tank in 1991, it contained approximately 950 L (250 gal) of residual, tar-like sludge. The sludge was collected and analyzed in March 2001. The principal chemical components of the sludge were NPH, TBP, iron oxide, and hexone. The principal radionuclides were americium-141, plutonium isotopes, strontium-90, and cesium-137 (CCN 100786).

Because the tank's integrity seems to be intact, an assumption for the conceptual model focused on the potential leaks associated with the pipe connections above the tank. Although no information about leak volumes from the pipe connections is available, the conceptual model assumes that 0.05 gal/hr, or 4,800 L (1,300 gal), could have leaked over the timeframe that the tank and associated piping were in service. Assuming that this potentially released volume is within the soils adjacent to and beneath the tank, the entire volume can be retained by the soils within 6.7 m (22 ft) of the ground surface. Thus, wastewater and mobile contaminants most likely have not affected the groundwater.

The status of groundwater contamination in the vicinity of tank 276-S-141 is described in PNNL-13788. The report indicates that groundwater concentrations of carbon tetrachloride, iodine-129, and uranium exceed groundwater protection standards beneath the site. Based on tank operation, these plumes are not associated with the tanks. Groundwater plumes in the 200 West Area are shown in Figures 3-3 and 3-4. Groundwater wells in the area of the waste site are sparse and distant. Groundwater monitoring wells are located west, southeast, and east-northeast of the tank site; however, because of the distance from the tank and other surrounding waste sites, these wells do not provide useful analytical information for the tank.

3.3.4.3 Combined Hexone Tank Sampling

In March 2001, tanks 276-S-141 and -142 were sampled and the samples were analyzed in accordance with DOE/RL-2000-73, Rev. 0, *Sampling and Analysis Plan for the 276-S-141/142 Hexone Tank Stabilization/Characterization Project*. The sampling event included deploying a video camera into the tanks through the 0.61-m (2-ft)-diameter riser to visually survey the inside of the tank and guide the survey efforts. Samples were collected through the 0.61-m (2-ft)-diameter riser and the 10-cm (4-in.)-diameter risers of each tank.

The video survey showed that the volume of residual material in both tanks was approximately 494 L (130 gal). No free liquid was observed in either tank. The sludge appeared to be a uniform, tar-like layer extending the length of the tank across the bottom with a dried, cracked crust. The sludge depth appeared to be approximately equal to the 8.25-cm (3.25-in.) diameter of the sample tool (beaker).

The video survey showed both tanks to be structurally sound. The tanks' internal surfaces appeared rusted, but had no apparent pits or voids. No evidence was present to suggest that either tank was leaking; however, no soil samples were taken from around the tanks. More details are provided in CCN 088368, *Hexone Tanks 276-S-141 and -142, VHS Videotape Notes*.

Analytical results for the sludge samples from tanks 276-S-141 and 276-S-142 are presented in CCN 100786. Table 2 of CCN 100786 contains results for sludge collected from tank 276-S-141; Table 3 contains results for sludge collected from tank 276-S-142; Table 4 summarizes the TRU analytical results for both tanks.

The sludge collected from tanks 276-S-141 and 276-S-142 can be characterized as a dark-colored, mildly acidic, phosphate tar. Sludge collected on the tanks' west ends was less viscous, with densities of 0.97 and 0.91 g/mL for tanks 276-S-141 and 276-S-142, respectively. Sludge collected from the tanks' east ends was more granular in texture, with densities of 1.21 and 1.20 g/mL for tanks 276-S-141 and 276-S-142, respectively. The pH of the sludge samples ranged from 3.2 to 4.8 (standard units). The principal chemical components of the sludge are normal petroleum hydrocarbons, tributyl phosphate, iron oxide, and hexone. The principal radionuclides detected in the sludge samples are americium-141, plutonium isotopes, strontium-90, and cesium-137. The sludge in tank 246-S-142 contains approximately four times the amount of radioactive material as the sludge in tank 246-S-141.

3.3.5 2607-W3 Septic Tank

3.3.5.1 Sources of Waste Contributions

The 2607-W3 septic tank received sanitary effluent from the 221-T, 222-T, 224-T, and 271-T Buildings. The tank operated from 1944 until it was filled with sand and abandoned in place in August 1996. Before being abandoned, the 2607-W3 septic system received approximately 14,200 L/day (3,745 gal/day) of waste. A contaminated process sewer line runs parallel to the sanitary sewer line in this area.

3.3.5.2 Maximum Volume of Waste Managed

The total effluent volume discharged to this site is estimated to be 270,000 m^3. This estimate is calculated from the 14,200 L/day (3,750 gal/day) rate reported in WIDS, which, in turn, is an average of the current and planned rates reported in WHC-SD-LL-ES-020.

3.3.5.3 Historical Sampling and Analysis

Limited information is available to evaluate the nature and extent of potential contamination beneath the 2607-W3 septic tank. Well 299-W11-7, drilled in September 1951, is located approximately 21 m (64 ft) to the southwest. No information was available regarding soil samples or radiological surveys in the vadose zone. Cesium was monitored from 1998 to 2001, with concentrations ranging from 0.182 to 1.36 pCi/L. Strontium was not monitored, and carbon tetrachloride was monitored from 1988 to 2001, with concentrations ranging from 230 to 2,500 µg/L.

The estimated effluent volume discharged to the soil column at this site is estimated to be 250,000,000 L (66,000,000 gal), which is greater than the estimate of the soil pore volume. (The soil pore volume was estimated following the approach outlined in DOE/RL-96-81.)

Although little information is available regarding the nature of contamination within the vadose zone at the subject site, a similar 200 West Area septic tank and drain field system has been studied. In September 1993, as part of the 200-UP-2 RCRA RFI/CMS documented in DOE/RL-91-19, Rev. 0, *200-UP-2 RCRA Facility Investigation/Corrective Measures Study*, borehole 299-19-97 was drilled to determine the possible northern extent of contamination from the 216-U-1 and 216-U-2 Cribs. The borehole was located approximately 20 m southwest of the drain field corner. The presence of perched water was investigated from the active 2607-W-5 septic tank and drain field. Perched water was not encountered in the borehole; however, a damp-to-moist interval was encountered at a depth of 55 ft in a silt lens. Contamination from cesium-137 and strontium-90 was detected at 4 ft bgs at concentrations of 22 and 3.3 pCi/g, respectively. The underground radioactive material is the result of an overflow to the ground from tank 241-U-361 and the 216-U-1 and 216-U-2 Crib vents (UPR-200-W-19). The overflow occurred in the spring of 1953, and decontamination was started that same year. The area was backfilled, delineated by a wooden fence, and posted with "radiation zone" signs. In 1992, contaminated soil in the vicinity of the 216-U-1 and 216-U-2 Cribs was scraped and consolidated near tank 241-U-361. The surface surrounding the tank was surface-stabilized with grout. The WIDS database indicates that the area was down-posted from a surface contamination area to an underground radioactive material (URM) area. The cesium-137 and strontium-90 analytical results reported in borehole 299-19-97 at 55 ft bgs are consistent with reports at 167 ft bgs beneath the 216-U-1 and 216-U-2 Cribs. The borehole sampling summary is provided in BHI-00034, Rev. 1, *Borehole Summary Report for the 200-UP-2 Operable Unit, 200 West Area*, and the radionuclide and chemical sample results are available from the HEIS database. The 2607-W-5 septic tank drain field that serves the 221-U Canyon Building and the 271-U Office Building are still active. The septic tank and associated diversion box are inside a URM area, but the tile field is located outside the URM boundary.

The status of groundwater contamination near the 2607-W3 septic tank is described in PNNL-13404, *Hanford Site Groundwater Monitoring for Fiscal Year 2000*. The report indicates that the carbon tetrachloride concentration in the groundwater exceeds the groundwater protection standards and guidelines near the crib. Based on process knowledge, this contaminant is not associated with waste disposal practices at this site. Major groundwater plumes in the vicinity of the 200 West Area and the 2607-W3 septic tank are shown in Figures 3-3 and 3-4.

3.3.6 Pipelines and Diversion Boxes

Releases of liquid wastes are documented for pipelines and diversion boxes primarily through UPR reports. Follow-up site characterization activities were conducted and provide some idea of waste distribution. In addition, a few pipelines have been studied as part of the RI process in other OUs. Characterization activities for at least one site within the 241-C tank farm are planned for FY05. The known information regarding nature and extent that has been collected to date or is anticipated in the near future is described in Appendix G.

3.3.6.1 Pipeline Sampling and Analysis

Releases from pipelines are known for a number of pipeline failures carrying high-activity waste streams. Many of these failures were reported in the period from 1945 through 1950. In most cases, the site was stabilized with gravel, asphalt, or shotcrete cover, and little characterization was undertaken. The UPR descriptions indicate that ground subsidence usually occurred over a failed line and that liquids were observed pooling or flowing over the ground surface. Following the advent of encasing pipelines in covered concrete troughs, leaks to the soil column were rare. This design collected liquid releases inside the encasement and drained the liquid to a downgradient diversion box/catch tank. Test or swab risers are installed on many of the pipeline encasements and have been used to assess leakage inside the encasement. The riser consists of 2-in., Schedule 40 pipe, which extends through the encasement cover block to above the ground surface and closes with a screw cap to isolate the encasement from the environment. Test risers are located at regular intervals along an encasement route. Historically, leaks were detected by lowering a swipe pad through the riser and contacting the encasement. A qualitative analysis for radionuclides was then conducted on the swipe with hand-held instruments. The risers were sampled on a regular basis, and all risers have been sampled. This data will be compiled during the RI and used to summarize the characteristics of historical leaks that have occurred within pipeline encasements. The video inspections of the encasement that have been conducted through the risers in the past will also be summarized.

UPR-200-E-86 represents a 1969 pipeline leak to the surrounding soil that was characterized by drilling in 1970 (ARH-1945, *B Plant Ion Exchange Feed Line Leak*) to determine the nature and extent of contaminant distribution following failure of a high-activity waste line. Additional drilling was performed in 1972. The leak was approximately 66,000 L (17,000 gal), containing 25,000 Ci of cesium-137 and contaminating approximately 36 m^3 (1,300 ft^3) of soil. The 1972 study to define the extent of contamination found no contamination below 6 m (20 ft). During the investigation, eight borings were drilled around the leak to define the release area. The site is marked by concrete "AC-540" marker posts at each corner. Waste site information in the WIDS database states that the surface has been covered with grout and is posted with URM signs.

In 1971 and 1972, 14 shallow borings were drilled to assess the soils adjacent to and beneath UPR-200-E-86. Contamination was reported for three of these borings according to *PSS Line Leak (Line No. 812)* (ARH 1972) and RHO-CD-673 (*Handbook – 200 Areas Waste Sites*). Elevated readings for cesium in the soil were reported from 0.3 to 5.5 m (1 to 18 ft) bgs. One of the borings was terminated at 1.8 m (6 ft) because the driller encountered radiation. The release was assumed to be associated with a joint in the pipeline.

According to RPP-7494, *Historical Vadose Zone Contamination from A, AX, and C Tank Farm Operations*, the contaminated area was 36 m^2 (387 ft^2). The depth of the contamination, 9 m (30 ft) bgs, was calculated from the volume of material spilled and soil column pore space.

Extrapolating from this information, wastewater and mobile contaminants have not reached groundwater because the soil column pore volume is greater than the estimated liquid release

The UPRs noted above encasements appear to be the result of root penetration into the encasement (UPR-600-20) or dispersion on the surface near test or swab risers. Characterization activities were conducted around the 241-EW-151 vent station in 1988 when a routine quarterly survey detected contamination outside of an established contamination zone (80322-88-090, *Surface Contamination Investigation Letter Report, Cross-Country Waste Transfer Line*). Laboratory analyses revealed 1,000 to 230,000 pCi/g cesium-137 and 100 to 27,000 pCi/g strontium-90 in soil samples identified by field instruments. Sagebrush samples contained 32 to 53 pCi/g cesium-137 and 2,700 to 37,000 pCi/g strontium-90.

Next, a drilling program was undertaken to determine if the encasement had leaked in the subsurface at locations where surface contamination was found in soil or vegetation. Investigations were conducted with two auger borings at each of four selected sites. One of the boring pairs was drilled along the centerline to the top of the encasement. A second hole was offset to miss the encasement and was drilled to below the encasement depth. Continuous split-spoon soil samples were taken and analyzed for radionuclides, but no radioactive contamination was found. The report concluded that the encasement had not leaked, and that the roots of sagebrush growing next to the encasement had penetrated to the interior of the encasement.

Leaks along moderate-activity pipelines are also known. UPR-200-W-163 was identified in 1995 as a zone of contaminated vegetation growing along the vitrified clay pipeline (VCP) connecting 221-U Plant to the 216-U-8 Crib. The pipeline was given an identification number of 200-W-42 and is being tracked in the WIDS. Characterization activities were undertaken as part of the 200-UP-2 OU to determine the distribution above and next to the pipeline. The field investigation was conducted in conjunction with the 200-UP-2 limited field investigation (LFI) (DOE/RL-95-13) and examined surface soil contamination and uptake of radionuclides and metals by vegetation at the 216-U-8 Crib. As part of the LFI, an integrity investigation also was conducted on the pipeline that discharged to the crib. The investigation was undertaken to determine the potential of this VCP to leak and cause soil contamination. The investigation consisted of surveying sections of pipeline with an in-line video camera and collecting 23 surface and near-surface soil samples to depths of 2 to 4 m (7 to 12 ft). The samples were collected in the area of the pipeline between Beloit Avenue and the 216-U-8 Crib. These depths represent the approximate location of the top of the pipeline in the subsurface. Activities and results are described in greater detail in BHI-00033 (*Surface and Near-Surface Field Investigation Data summary Report for the 200-UP-2 Operable Unit*) and DOE/RL-95-13.

The pipeline integrity investigation yielded a number of observations. In the vitrified clay section of the pipeline, many of the joints were dislodged, allowing silty sandy material to enter the pipeline. The degree of dislodgment varied from minor to very serious. The stainless-steel section of the pipe was in excellent condition and the joints were sound.

Surface-soil samples collected during the pipeline investigation typically showed background levels of activity for analyzed-for constituents. The highest levels of contamination were detected in the subsurface near the VCP; however, many constituents were distributed throughout the 4 m (12 ft) depth being investigated. The data also suggested that minor lateral spreading (no more than 1 to 2 m [3 to 5 ft]) occurred. The maximum concentrations of americium-241, cesium-137, plutonium-239/240, and strontium-90 detected during the pipeline investigation were 426 pCi/g, 49,100 pCi/g, 70.6 pCi/g, and 1,380 pCi/g, respectively. The highest strontium activity was detected in a vegetation sample. Soil sampling results for constituents are presented graphically in BHI-00033 and are discussed in DOE/RL-2000-60.

3.3.6.2 Diversion Boxes Sampling and Analysis

Diversion boxes and catch tanks are also associated with a number of UPRs. Opportunities exist for releases at these locations due to the operations required to change routings inside the box. Most of the documented UPRs are the result of releases to the atmosphere and dispersion on the surface and are not leaks where liquids have infiltrated into the soil. Removing cover blocks opens the interior to winds and the atmosphere, and speck contamination may be blown out and deposited on the ground. In some cases, equipment removed from a diversion box or catch tank may have spread contamination to the surface. Failed jumpers or misrouting has resulted in process waste streams flooding some diversion boxes and/or catch tanks and subsequent overflow and spills onto the ground surface. There is at least one instance where a pipeline connection at the exterior of a diversion box has failed (UPR-200-W-113) and spilled contamination to the subsurface. Several catch tanks have been replaced due to unspecified failures.

Characterization activities have been conducted at the 200-W-59 diversion box, which is a structure associated with the 216-Z-12 Crib. Site characterization activities were conducted at the 200-W-59 diversion box in 1976. Four shallow wells (299-W-18-151, 299-W-18-154, 299-W-18-155, and 299-W-18-156) were drilled in 1976 between the 216-Z-12 Crib and 200-W-59 and to evaluate the near-surface soils. All of the wells showed plutonium contamination activity at approximately 5 m (16.4 ft). The source of the contamination is thought to be unsealed joints of VCP that extend from the south side of the diversion box to the crib. RHO-ST-21, *Report on Plutonium Mining Activities at 216-Z-9 Enclosed Trench*, stated that engineering drawings did not specify seals to be used for the butted VCP connections between the diversion box and the crib. The report also indicated that the VCP sections were 3 m (10 ft) long. The log for well 299-W18-156 reported contamination at 5.3 to 5.5 m (17.5 to 18 ft) bgs. This well is approximately 3.7 m (12 ft) to the west of the 200-W-59 diversion box and is the closest of the four wells drilled. Other activity measurements in wells adjacent to and beneath the 216-Z-12 Crib reported that the bulk of the plutonium was sorbed onto sediments within 3 m (10 ft) of the crib bottom and decreased rapidly with depth. Plutonium activity at 12 m (39 ft) beneath the crib was reported at less than 1 pCi/g. However, low-level plutonium and americium activity was detected from 30 to 36 m (98 to 118 ft) beneath the crib (36 m [118 ft] was the maximum depth sampled).

In addition, characterization is planned in the near future by CH2M Hill Hanford Group, Inc. (CHG) for diversion boxes 241-B-151, 241-B-152, and 241-B-153 in the 241-B Tank Farm. Subsurface soil adjacent to each box will be characterized by four drive casings (i.e., one at each corner of each structure), which will be geophysically logged. Where contamination at depth is detected in a borehole, a second hole will be advanced and a sample taken at the location of highest activity. This information will be correlated with the diversion box histories, and an assessment will be conducted to document the nature and extent of contamination in the subsurface.

3.3.7 Conceptual Contaminant Distribution Models

Preliminary conceptual contaminant distribution models were developed for the 200-IS-1 OU and 200-ST-1 OUs in the *Waste Site Grouping Report for 200 Areas Soil Investigations* (DOE/RL-96-81). These preliminary models were updated as part of the DQO process, and the revised models are presented in this section. The conceptual contaminant distribution models are based on available site-specific data and knowledge gained by evaluating other 200 Area waste sites. The conceptual contaminant distribution models were developed based on a general understanding of contaminant transport and fate as it would apply to potential releases in soils adjacent to pipelines, diversion boxes, the 241-CX tank system, and the HSTF.

Information pertaining to contaminant sources, release mechanisms, and transport media has been incorporated into this discussion of the conceptual contaminant distribution models. This information will support an evaluation of the potential risk to human health and the environment. The conceptual exposure pathway model that discusses exposure routes and receptors is included in Section 3.5.

The following general conclusions can be drawn regarding the conceptual contaminant distribution models for the waste sites:

- The major radionuclide COCs are cesium-137, plutonium-238, plutonium-239, plutonium-240, strontium-90, uranium-234, uranium-235, and uranium-238.
- Few of the waste sites received enough effluent to affect groundwater.
- Contamination migrated vertically beneath the waste sites after release. Lateral spreading of liquids and contaminants may have occurred at the bottom of the waste site, at the sand-dominated sequence of the Hanford formation, at the Cold Creek unit, and/or at the Upper Ringold Formation, if present.
- Contaminants such as cesium-137 and the plutonium isotopes normally sorb strongly onto shallow-zone Hanford Site sediments and, therefore, have high distribution coefficients (K_ds). These less mobile contaminants should be detected near points of release in the vadose zone. Contaminants with low K_d values (e.g., nitrate, technetium-99 and tritium) are not readily adsorbed on soil particles and migrate to greater depth within the vadose zone. For example, cesium-137 (K_d > 2,000 mL/g) is likely to concentrate near the point of release; strontium-90 (K_d = 0.4 to 50 mL/g) and uranium (K_d = 1 mL/g) would be expected at greater depths. Tritium, with a K_d value equal to 0, will migrate vertically with the wetting moisture front (DOE/RL-2000-38, Rev. 0, *200-TW-1 Scavenged Waste Group Operable Unit and 200-TW-2 Tank Waste Group Operable Unit RI/FS Work Plan*).
- The RCRA TSD units no longer receive effluent. With the cessation of artificial recharge, the downward flux of moisture through the vadose zone has decreased. Residual moisture should continue to decrease in the vadose zone over time and equilibrate with the natural recharge rate, thus reducing the potential for future impacts to groundwater.

Conceptual contaminant distribution models for process pipelines, diversion boxes, catch tanks, the 241-CX tank system, the 276-S-141 and 276-S-142 storage tanks, and the 2607-W3 septic tank are presented in the following figures:

- Figure 3-5 shows the process pipelines
- Figure 3-6 shows a diversion box and catch tank
- Figure 3-7 shows the 241-CX-70 storage tank
- Figure 3-8 shows the 241-CX-71 storage tank
- Figure 3-9 shows the 241-CX-72 storage tank
- Figure 3-10 shows the 276-S-141 and 276-S-142 hexone storage tanks
- Figure 3-11 shows the 2607-W3 septic tank contaminant distribution model.

Potential receptors (human and ecological) may be exposed to the affected media through several exposure pathways, including inhalation, ingestion, and direct exposure to external gamma radiation. Potential human receptors include current and future site workers and visitors (occasional users). Potential ecological receptors include terrestrial animals. The conceptual exposure model for the 200-IS-1 and 200-ST-1 OUs is shown in Figure 3-12.

Future impacts to humans largely depend on prominent exposure pathways indicated by future land uses. A restricted land-use scenario has been identified for the core zone. All sites in the 200-IS-1 OU and 200-ST-1 OU are located in the core zone.

3.3.8 Ecological Information

The section introduces the *Central Plateau Ecological Evaluation Report* (DOE/RL-2001-54), which serves as the basis for ecological evaluation activities in the Central Plateau. The Central Plateau includes the 200 East, 200 West, and 200 North industrial areas and portions of the largely undisturbed 600 Area. This section also summarizes existing 200-IS-1 and 200-ST-1 OU-specific ecological sampling and analysis information. Results of ecological sample are considered in the analysis of impacts to human health and the environment.

3.3.8.1 Central Plateau Ecological Evaluation Report

The *Central Plateau Ecological Evaluation Report* (DOE/RL-2001-54) has been prepared to support ecological evaluations under the RI/FS process for Central Plateau waste sites. DOE/RL-2001-54 completes a screening-level ecological risk assessment for the Central Plateau in accordance with the eight-step U.S. Environmental Protection Agency (EPA) ecological risk assessment process presented in *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 540/R-97/006). The first two steps of the process, the screening-level assessment, are presented in the document (see Figure 1-1 in DOE/RL-2001-54).

The document contains a compilation and evaluation of ecological sampling data that have been collected over many years from undisturbed and disturbed habitats in the Central Plateau. The ecological evaluation document helps answer questions about the ecological resources in the Central Plateau that are important to preserve and protect. The document also identifies ecological data needs that can be addressed in future ecological sampling activities on the Central Plateau.

The document includes descriptions of the habitats in the Central Plateau, including sensitive habitats and the plants and animals that inhabit them. The document identifies potential species of concern, including threatened and endangered species and new-to-science species. A detailed survey of the Central Plateau was conducted in 2000 and 2001, and the results are incorporated into the ecological evaluation document. The information from the survey provides a detailed description of the ecological setting of the Central Plateau and augments the ecological information presented in this work plan.

3.3.8.2 200-IS-1 and 200-ST-1 Operable Unit-Specific Ecological Information

A summary of ecological resources for the 200 Areas is provided in Appendix F, Sections 8.0 and 9.0 of the Implementation Plan (DOE/RL-98-28). Available information pertaining to sampling of vegetation and biota within the 200-IS-1 and 200-ST-1 OU waste sites is presented in this section to summarize existing ecological data and as input to Section 3.5 on potential impacts to human health and the environment. Several other sources of information, while not pertinent to all the waste sites, provide useful data in the vicinity of some of the waste sites.

Eighty-five environmental monitoring records of wildlife and vegetation at the 200 East and West Areas taken since 1965 were reviewed and summarized in WHC-MR-0418, *Historical Records of Radioactive Contamination in Biota at the 200 Areas of the Hanford Site*. The report identifies the areas within the 200 Areas that were sampled between 1965 and 1993. Approximately 4,500 individual cases of monitoring for radionuclide uptake or transport in biota in the 200 Area environs were included in the documents reviewed in WHC-MR-0418. Approximately 2,400 samples were collected from near the operations areas, and only about 120 samples (i.e., approximately 5%) exceeded radionuclide concentrations of 10 pCi/g. Roughly 2,100 biotic samples were collected during special investigations at known or suspected contaminated sites, and about 1,800 (i.e., approximately 86%) exceeded concentrations of 10 pCi/g, indicating that radionuclide contamination has remained relatively localized even though it has spread beyond intended waste site boundaries. WHC-MR-0418 further states that the routine monitoring is targeted to detect potential radioactive contamination at nuclear facilities and waste sites, and the special investigative samples are usually targeted at known incidents of biotic uptake and transport. Therefore, both results are biased toward detection of radioactivity. These radionuclide transport or uptake cases were distributed among 45 species of animals (mostly small mammals), feces, and 30 species of vegetation.

Only one location near a 200-IS-1 OU waste sites was field surveyed or analytically sampled between 1965 and 1993 (WHC-MR-0418). Samples of vegetation (cheatgrass and terrestrial composite samples) and rabbit and coyote feces were collected from 1978 to 1988 and analyzed for cesium-137, strontium-90, and plutonium-239. These samples were collected outside of the 221-U Facility, which is located near the 216-U-7 and UPR-200-W-138 sites within the 200-IS-1 OU. All but two samples contained radionuclide concentrations of less than 1.0 pCi/g. The two exceptions were terrestrial vegetation and rabbit feces samples collected in 1982 that contained 1.2 and 8.0 pCi/g of cesium-137, respectively (PNL-4657, *Environmental Surveillance at Hanford for CY 1982*).

In recent years, however, the frequency and breadth of biological (wildlife) sampling has been limited to terrestrial biota such as elk and rabbits (PNNL-13230, *Hanford Environmental Monitoring Report for Calendar Year 1999*). Analytes sampled under the radionuclide monitoring program include gamma-emitting radionuclides, strontium isotopes, uranium isotopes, and plutonium isotopes. Media sampled include soil, vegetation, nests (birds, wasps, and ants), mammal feces (rabbits and coyotes), mammals (mice and bats), and insects (fruit flies). Results of investigative sampling are reported in annual Hanford Site environmental monitoring reports (e.g., PNNL-13230 and PNNL-13316). A large volume of radionuclide data exists as a result of the annual monitoring program; however, nonradiological constituents have not been analyzed under this program.

Wildlife species most commonly associated with uptake of radioactive contamination in the 200 Areas historically have been house mice and deer mice, but other animals such as birds (including waterfowl), coyotes, cottontail rabbits, mule deer, and elk have been sampled (WHC-MR-0418; PNNL-12088, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1998*). In 1999, the Pacific Northwest National Laboratory sampled elk, geese, and rabbits for gamma emitters and strontium-90. Samples of elk muscle, bone, liver, heart, kidney, intestine, and feces were collected from animals struck on Hanford Site roadways and on the 200 Area Plateau. Cesium-137 was undetected in all elk samples. PNL-10174, *A Qualitative Evaluation of Radionuclide Concentrations in Hanford Site Wildlife, 1983 Through 1992*, reported a consistent decline in cesium-137 concentration in elk since 1983. Geese were sampled from the Hanford Reach near the Vernita Bridge. Only one of the eight geese sampled showed a cesium-137 concentration above analytical detection. Eight rabbit samples, consisting of jackrabbit and cottontail muscle and bone, were taken from the 200 Areas in 1999. One of the eight rabbit muscle samples showed a cesium-137 concentration above analytical detection. Strontium-90 was detected in bones of all eight samples; however, according to PNNL-13230, the results from animals sampled near the 200 Areas did not suggest significant exposure attributable to Hanford operations.

Plant species could potentially be exposed to contaminated soils present in the 200 Area vadose zone because they live in direct contact with the soil and can take up contaminants through physical and biological processes. The extent of exposure is a function of the plant species, root depth, physical nature of the contamination, and the contaminant concentrations and distributions in the soil. Plants themselves generally are tolerant of ionizing radiation (IAEA-TECDOC-332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*) but present a potential contaminant pathway to wildlife through the consumption of contaminated seeds, leaves, roots, or stalks. Radionuclide uptake by plants within the 200 Areas was reported in WHC-MR-0418.

The vegetative species most commonly associated with the contamination was Russian thistle. The largest numbers and levels of radionuclide uptake or transport occurred at several sites unrelated to the 200-IS-1 and 200-ST-1 OUs, including the 216-Z ditches, 216-B-3 ditches, 216-BC Cribs, B Tank Farm, and BX and BY Tank Farms. Much of the sampling data were collected before stabilization activities began at the individual waste sites. Noticeable improvements in reducing uptake and transport of radionuclide contaminants by biota were observed in areas where interim stabilization activities have taken place (WHC-MR-0418).

In 1993 and 1994, a sampling effort was conducted to collect ecological samples at four sites within the 200 Areas (BHI-00032, *Ecological Sampling at Four Waste Sites in the 200 Areas*). The basis of the sampling strategy was to select some worst-case sites for sampling, to focus future biota sampling activities. Control samples were collected from a site on the Saddle Mountain Wildlife Refuge. Soil, vegetation, small mammal, and insect samples were collected and analyzed for the EPA's target analyte list (SW-846, *Test Methods for Evaluating Solid Waste: Physical/Chemical Methods*) constituents, strontium-90, total uranium, and gamma-emitting radionuclides using gamma spectroscopy. Soil and vegetation samples were also analyzed for technetium-99.

Vegetation analysis included cheatgrass, cheatgrass/wheatgrass, and Russian thistle samples. Radionuclides detected in vegetation included strontiumg-90 (in both Russian thistle samples and both grass samples), cesium-137 (in one Russian thistle sample and both grass samples), and total uranium in one grass sample. Chromium and cobalt were detected in one grass sample, but both analytes also were present in the associated sample blanks. Copper was detected in one Russian thistle sample and both grass samples. However, copper was also present in the associated sample blanks for those samples, and the concentration of copper present in one grass sample was estimated. Zinc was detected in two Russian thistle samples and in one of the grass samples.

BHI-00032 concluded that Russian thistle is the preferred vegetative indicator for radionuclide and metal uptake, and pocket mice are the preferred mammalian indicators of contaminant uptake at terrestrial sites. Of the four sites sampled and described in BHI-00032, the 216-A-24 Crib had the highest reported vegetation concentrations of strontium-90, cesium-137, chromium, zinc, and copper.

A 1994 field investigation of the 200-UP-2 OU (BHI-00033), which was conducted in conjunction with the 200-UP-2 OU LFI (DOE/RL-95-13), examined surface soil contamination and uptake of radionuclides and metals by vegetation at the 216-U-8 VCP, which is now officially known as waste site 200-W-42 in the WIDS database. Although this pipeline is not a 200-IS-1 OU waste site, the ecological data from this investigation can be applied to other pipelines in the 200-IS-1 OU that exhibit the same or similar physical attributes.

Vegetation samples were taken at the 216-U-8 VCP and the 216-U-8 Crib and analyzed for a series of metals and radionuclides. Sampling results for each site are listed in Tables 3-1 and 3-2nd also can be found in Appendix B of BHI-00033. Fourteen surface and subsurface samples, as well as four vegetation samples, were collected at the 216-U-8 VCP site. Four metal COCs (including antimony, barium, copper, and lead) and seven radionuclide COCs (including cesium-137, plutonium-239/240, technetium-99, thorium-232, total strontium, uranium-234, and uranium-238) were detected in vegetation samples near the 216-U-8 VCP site.

In a 1999 sampling effort described in the Hanford Site environmental report (PNNL-13230), 55 soil samples and 48 vegetation samples were collected in the 200 and 600 Areas. Vegetation and soil samples were collected from one 200-IS-1 waste site, the 200-W-59 diversion box, under the Hanford Site near-facility monitoring program (e.g., PNNL-13316). Soil and vegetation samples were collected from station D021/V021, located inside the 200-W-59 diversion box boundary. Soil and vegetation concentrations of radionuclides for the D021/V021 monitoring site are listed in Table 3-3. All soil and vegetation samples contained radionuclide concentrations of less than 1.0 pCi/g.

In a 2001 sampling effort described in *Hanford Site Environmental Report 2001: App. 1: Environmental Surveillance Data Report – App. 2: Near-Facility Environmental Monitoring Data Report – Sum: Summary of the Hanford Site Environmental Report – for Calendar Year 2001* (PNNL-13910), 57 soil samples and 49 vegetation samples were collected in the 200/600 Areas. Soil samples consisted of a composite of five plugs of soil, each 2.5 cm (1 in.) deep, and 10 cm (4 in.) in diameter, from each sampling location. Perennial vegetation samples consisted of the current year's growth of leaves, stems, and new branches collected from sagebrush and rabbitbrush. Surveillance of perennial vegetation in 1998 generally confirmed observations of past sampling efforts. Radionuclide analyses indicated that cobalt-60, strontium-90, cesium-137, plutonium-239/240, and uranium consistently were detectable in both soil and vegetation. Fission products were most common in the 200 Areas. A total of 31 Sitewide investigative vegetation samples were analyzed for radionuclides in 2001. Of the samples analyzed, 27 showed measurable levels of activity. Eight tumbleweed fragments showed elevated field readings, with five of the eight samples originating from the 218-E-12B Burial Ground (part of the 200-SW-2 OU) in the 200 East Area (PNNL-13910).

As reported in PNNL-12088, Appendix 2; PNNL-13230, Appendix 2; PNNL-13487, Appendix 2 (*Hanford Site Environmental Report for Calendar Year 2000*); and PNNL-13910, Appendix 2, for calendar years 1998 through 2001, soil and vegetation samples were collected near a number of 200 Area waste sites. The exact locations of these samples are shown in the referenced documents. Surface surveys are conducted annually at the waste sites and include vegetation, animal burrows, and feces. Surveys are conducted with vehicles equipped with radiation detection instruments or hand-held field instruments. Special surveys also are conducted at these waste sites if conditions warrant (i.e., growth of deep-rooted vegetation is observed). A more detailed discussion of the annual monitoring can be found in DOE/RL-91-50, Rev. 3, *Environmental Monitoring Plan, U.S. Department of Energy, Richland Operations Office*.

Investigative wildlife sampling was used to monitor and track the effectiveness of measures designed to deter animal intrusion. Wildlife-related materials, including nests, carcasses, and feces, were collected as part of the integrated pest management program or when encountered during a radiological survey. Samples were analyzed for radionuclides and/or other hazardous substances, with disposal contingent on the level of contamination present. In 2001, five wildlife samples were submitted for analysis. The maximum radionuclide activities in 2001 were in mouse feces collected near the 241-TX-155 diversion box (part of the 200-IS-1 OU) in the 200 East Area. Contaminants included strontium-89/90, cesium-137, europium-154, plutonium-238, and plutonium-239/240 (PNNL-13910). The number of animals found to be contaminated with radioactivity, their radioactivity levels, and the range of radionuclide activities were within historical levels (PNNL-13910).

Biological transport of contamination by ants also is a concern on the Hanford Site. Harvester ants, which are present on the disturbed soils associated with waste sites, have shown extreme resistance to radioactive sources (Gano 1980). In a contamination area, ants can bring radioactive materials to the surface, where they could be susceptible to other means of transport by wind, plant uptake, birds, or mammals. The biological transport of contamination by harvester ants was documented during an annual radiological survey at the UPR-200-E-64 site in 1985. The source of contamination was assumed to be a small-diameter pipe visible on the west side of the 216-B-64 retention basin, near tank 270-E-1 in the 200-SC-1 OU. In 1985, the pipe had a dose rate of 30 mrad/hr. Surrounding contamination was transported to the surface by harvester ants, and further spread by wind. The size of the area of contamination in 1995 was approximately 8,100 m^2 (2 ac), and currently is posted as a soil contamination area. Additional contaminated soil and anthills were identified both north and south of 7th Street and around the 241-ER-151 diversion box (part of the 200-IS-1 OU) in September 1998.

3.4 RCRA TREATMENT, STORAGE, AND DISPOSAL UNIT INTERIM STATUS GROUNDWATER MONITORING

Neither the 241-CX tank system nor the HSTF is involved in interim status groundwater monitoring.

3.5 POTENTIAL IMPACTS TO HUMAN HEALTH AND THE ENVIRONMENT

This section presents the conceptual exposure model developed to identify potential impacts to human health and the environment from waste sites in the 200-IS-1 and 200-ST-1 OUs. Information pertaining to contaminant sources, release mechanisms, transport media, exposure routes, and receptors is discussed to develop a conceptual understanding of potential risks and exposure pathways. This information will be used to support an evaluation of potential human health and environmental risk in the RI/FS to be prepared following the investigation.

3.5.1 Contaminant Sources and Release Mechanisms

The primary sources of contamination at waste sites in the 200-IS-1 and 200-ST-1 OUs were effluents from tanks, lines, pits, diversion boxes, and septic tanks with their associated drain fields. The waste generally was released to the vadose zone through UPRs from tanks. Releases to the environment from the primary contaminant sources have produced contaminated surface soils and subsurface soils beneath waste sites. These are secondary sources that can spread contaminants through the environment by infiltration, resuspension of contaminated soil, volatilization, biotic uptake, leaching, and external radiation. During the periods when waste sites received effluent, the dominant mechanism of contaminant transport was infiltration. After effluent disposal ceased, the liquids continued to move through the soil column for an undetermined period. Currently, the dominant mechanism of contaminant transport through the vadose zone is assumed to be from residual effluent moisture and natural recharge.

3.5.2 Potential Receptors

Potential receptors (i.e., human and ecological) can be exposed to the affected media through several exposure pathways, including the following:

- Ingestion of contaminated soils (including dust inhalation), sediments, or biota
- Inhalation of contaminant dusts, vapors, or gases
- Dermal contact with contaminated soils or sediments
- Direct exposure to external gamma radiation in site soils and sediments.

Potential human receptors include current and future Site workers and Site visitors (i.e., occasional users). Under a restricted future land-use scenario, site worker and visitor exposure pathways primarily would involve incidental soil and sediment ingestion; inhalation of contaminants, dermal contact with contaminated soils and sediments, and external gamma radiation (Figure 3-12). Potential ecological receptors include terrestrial plants and animals inhabiting the sites. Site biota exposures would primarily result from incidental soil and sediment ingestion, plant uptake, ingestion of contaminated plant or animals (e.g., grazing or predation), dermal contact with contaminated soils and sediments, and external gamma radiation.

3.5.3 Potential Impacts

Potential contaminant exposures and health impacts to humans depend largely on allowable land uses. The land use inside the core zone selected by DOE is industrial (exclusive). Outside the core zone, the selected land use is conservation (mining). The DOE determined these land-use designations through the *National Environmental Policy Act 1969* (NEPA) process; the designations are identified in the DOE/EIS-0222-F and documented in the Comprehensive

Land-Use Plan ROD (64 FR 61615). The 200-IS-1 RCRA TSD units are all located within the core zone. Therefore, based on the land-use decision for the 200 Areas, potential impacts from the waste site contaminants within the core zone would be to current and future Site workers and to terrestrial biota inhabiting the sites.

Ecological receptors have been identified and potential impacts to those receptors have been evaluated at waste sites within the 200 Areas (PNNL-13404, Appendix 2; PNL-2253, *Ecology of the 200 Area Plateau Waste Management Environs: A Status Report*; WHC-SD-EN-TI-216, *Vegetation Communities Associated with the 100 Area and the 200 Area Facilities on the Hanford Site*). The vegetation cover on the 200 Area Plateau is predominantly a rabbitbrush-cheatgrass and sagebrush-cheatgrass association with incidence of herbaceous and annual species. Many areas are disturbed and nonvegetated or sparsely vegetated with annuals and weedy species such as Russian thistle. Potential ecological contaminant exposures at the waste sites are minimized because of past site stabilization activities.

DOE/RL-2001-54 presents a more recent evaluation of habitats on the Central Plateau and provides a screening-level risk assessment, including an evaluation of threatened and endangered and new-to-science species that may be associated with the Central Plateau.

Existing characterization data and proposed sampling at representative waste sites are expected to be sufficient to address potential impacts to human health and the environment.

3.6 DEVELOPMENT OF CONTAMINANTS OF CONCERN

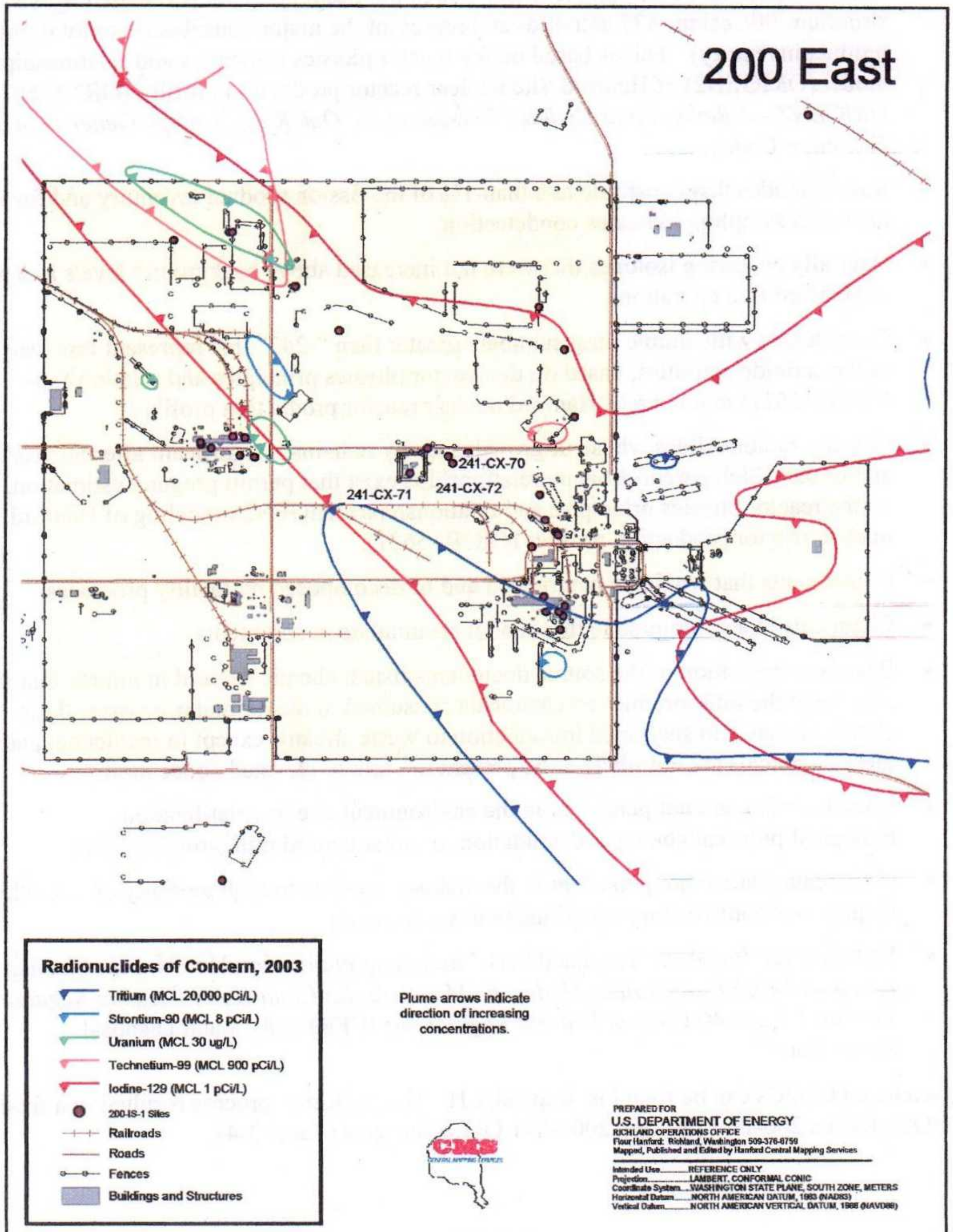
The COCs identified for the 200-IS-1 OU and 200-ST-1 OU waste sites were originally determined as part of the RI/FS DQO process conducted in 2002 (CP-13196). However, after integration of the ORP-owned waste sites into this revision of the work plan, a new master COPC list was created. The follow-up DQO assessment conducted to address the additional waste sites indicated that potentially any or all of the waste streams associated with the various 200 Area facilities could have come in contact with or been routed through the waste site structures,. This master list of COPCs was developed based on process and waste site knowledge using all 200 Area process-based OU RI/FS DQO documents and tank farm "tier 1" constituents, including previous 200-IS-1 OU and 200-ST-1 OU COPCs. The 200 Areas master COPC list can be found in Appendix H.

The final COC list was determined by evaluating the COPCs against a set of exclusion criteria and past sampling and characterization activities. Exclusion criteria (including various physical and chemical characteristics such as toxicity, persistence, and chemical behavior in the environment) were considered. Substances resulting from 200 Area waste streams that had high volatility, rapid environmental degradation relative to the age of the waste site, low potential for bioaccumulation, and low bioavailability are properties and characteristics that would result in minimal human health and environmental risk from specific COPCs and would not likely represent important human health or environmental risks. Conversely, contaminants with properties of high persistence, slow degradation, high bioavailability, and high potential for bioaccumulation are properties and characteristics that would result in potentially significant risks and these constituents would be retained as COCs. Basic exclusion criteria for constituents are as follows:

- Short-lived radionuclides with half-lives of less than 3 years.
- Radionuclides that constitute less than 1% of the fission product (evaluated against strontium-90/cesium-137 activities and represent the major contributors to total fission product inventory). This is based on the reactor physics principles and relationships model (ORIGEN2) of Hanford Site nuclear reactor production profiles (ORNL-5621, *ORIGENZ - A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*).
- Radionuclides that constitute less than 1% of the fission product inventory and for which historical sampling indicates nondetection.
- Naturally occurring isotopes that were not increased above background levels as a result of Hanford Site operations.
- Constituents with atomic mass numbers greater than "-242" that represent less than 1 % of the actinide activities, based on the reactor physics principles and relationships (ORNL-5621) modeling of Hanford nuclear reactor production profiles.
- Progeny radionuclides whose in-growth activity remains insignificant after 50 years and/or for which parent-progeny relationships exist that permit progeny estimation, based on the reactor physics principles and relationships ORIGEN2 modeling of Hanford nuclear reactor production profiles (ORNL-5621).
- Constituents that would be neutralized and/or decomposed by facility processes.
- Chemicals in a gaseous state that cannot accumulate in soil media.
- Based on evaluation of the source documents listed, chemicals used in minute quantities relative to the bulk-production chemicals consumed in the normal processes; these chemicals have no suspected introduction to waste streams except in incidental quantities these chemicals are not likely to be present in toxic or elevated concentrations.
- Chemicals that are not persistent in the environment due to volatilization, biological/physical/chemical degradation, or other natural mitigating features.
- Chemicals that are not persistent in the vadose zone due to high mobility or as evidenced by previous confirmatory sampling/analysis activities.
- Materials not found on "regulated lists," including Publication No. 94-145, *Cleanup Levels and Risk Calculations Under the Model Toxics Control Act Cleanup Regulation, Version 3.1* and 40 *Code of Federal Regulations* (CFR) 268, "Land Disposal Restrictions."

All excluded COPCs can be found in Appendix H. The exclusion process resulted in a final list of COCs for the 200-IS-1 OU and 200-ST-1 OU waste sites (Table 3-4).

Figure 3-1. Major Radiological Groundwater Plumes in the Vicinity of the 200 East Area.



O:\Projects\OperableUnits\200IS1_200ST1\040517_200IS1_200ST1_WorkPlan_Webb\Maps\021024_2_contam_plume_200e_Rad_galgoul.mxd

Figure 3-2. Major Nonradiological Groundwater Plumes in the Vicinity of the 200 East Area.

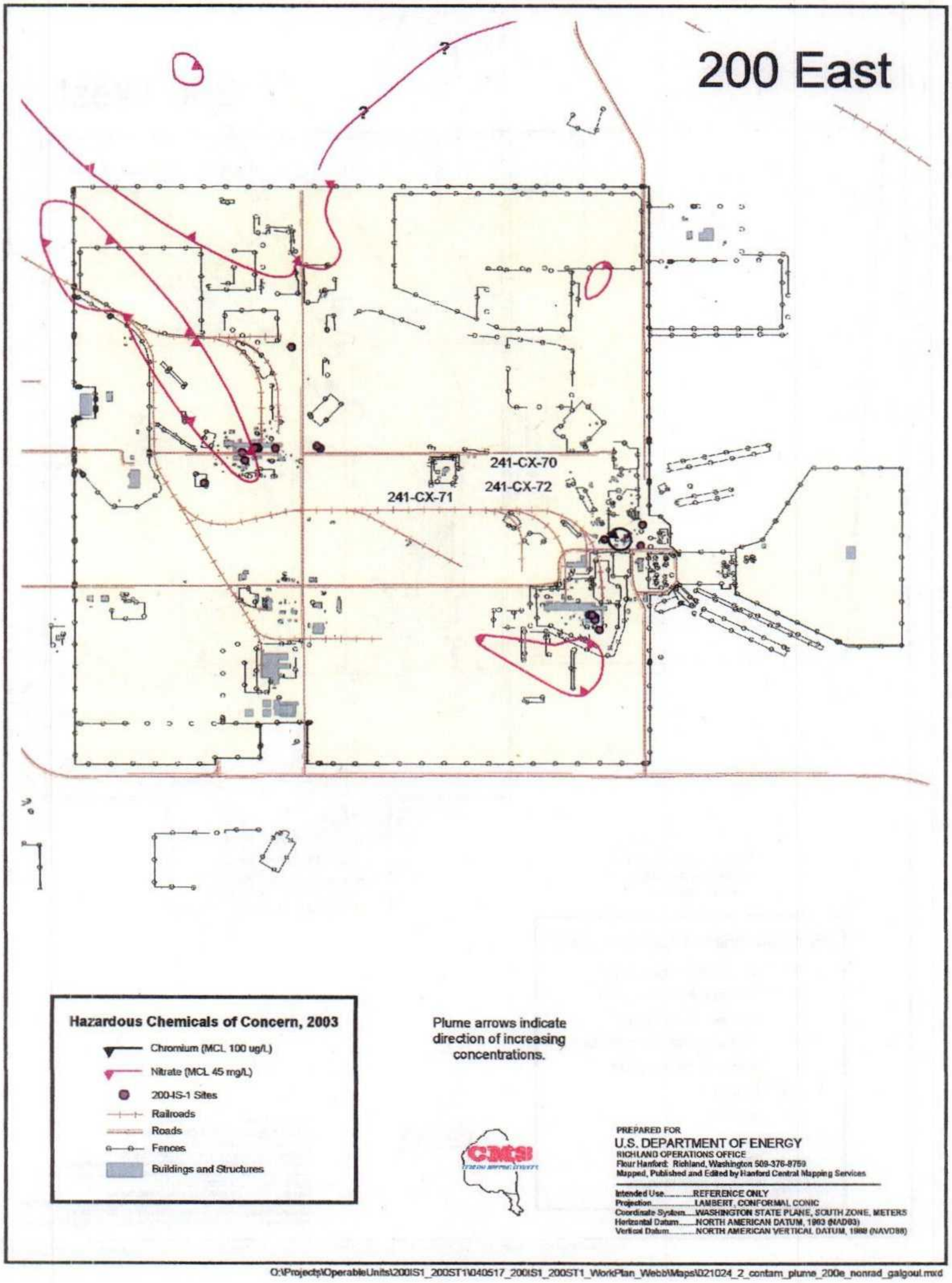
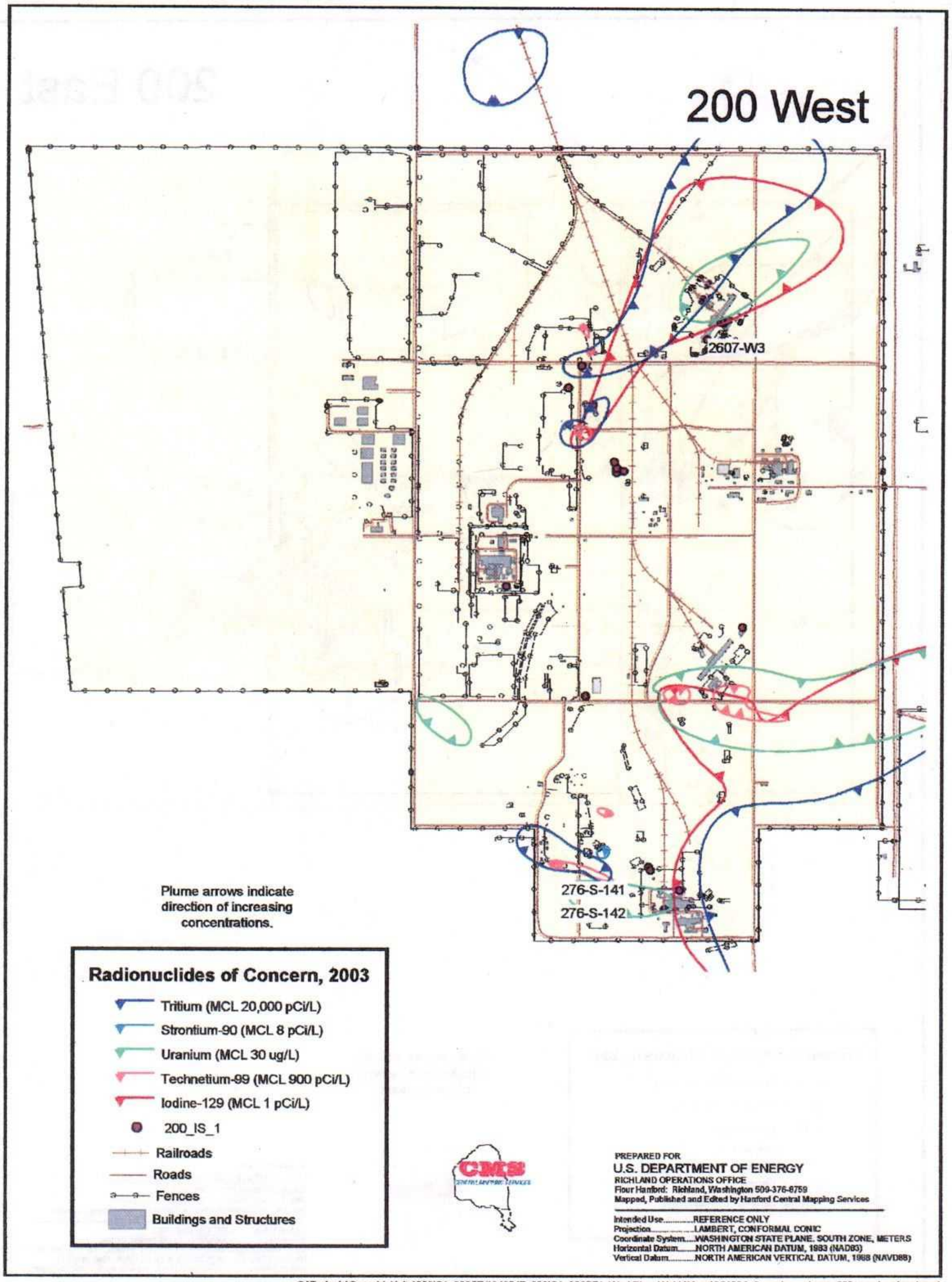


Figure 3-3. Major Radiological Groundwater Plumes in the Vicinity of the 200 West Area.



C:\Projects\OperableUnits\200IS1_200ST1\040517_200IS1_200ST1_WorkPlan_Webb\Maps\021024_3_contam_plume_200w_rad_galgoul.mxd

Figure 3-4. Major Nonradiological Groundwater Plumes in the Vicinity of the 200 West Area.

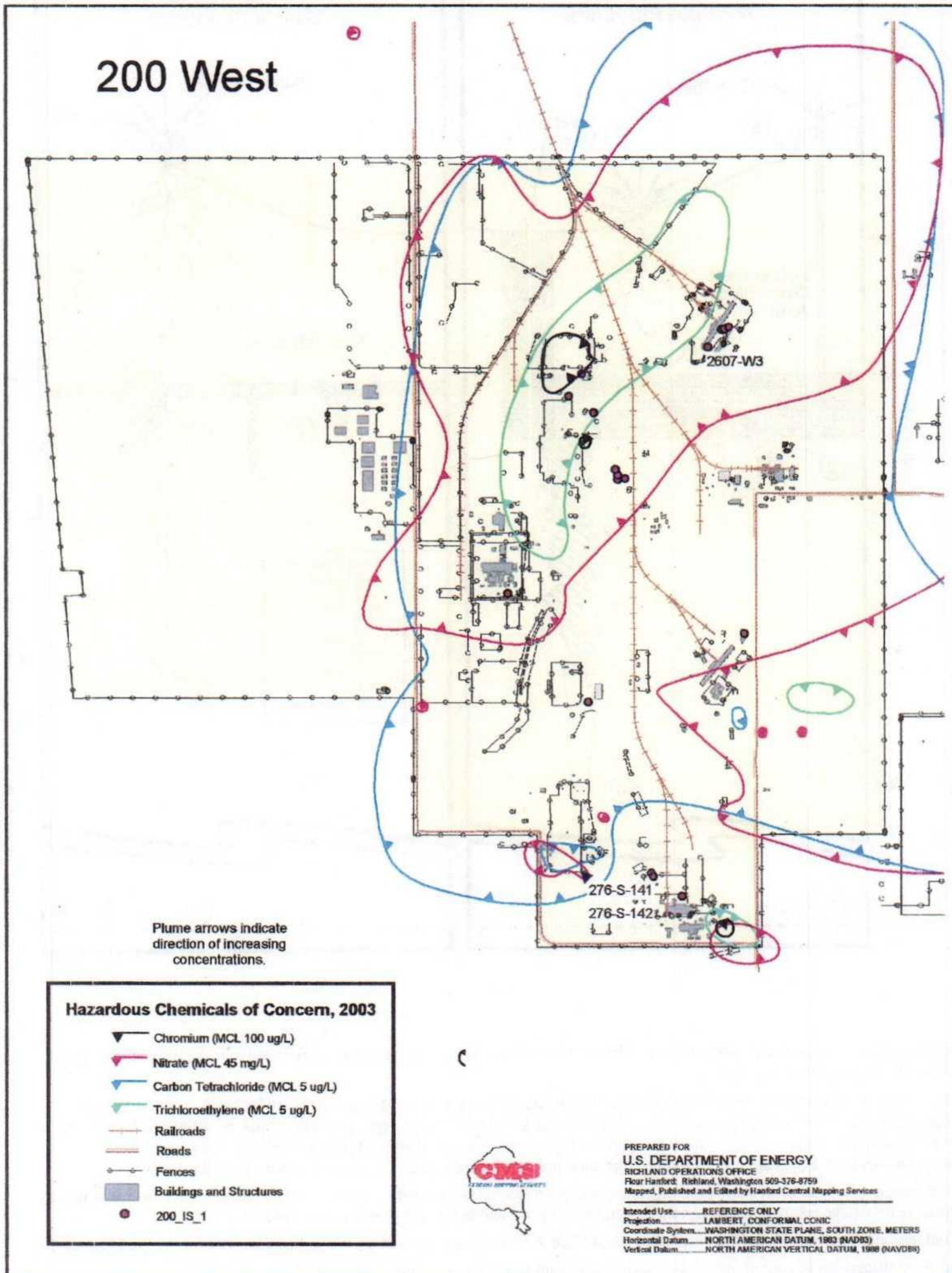


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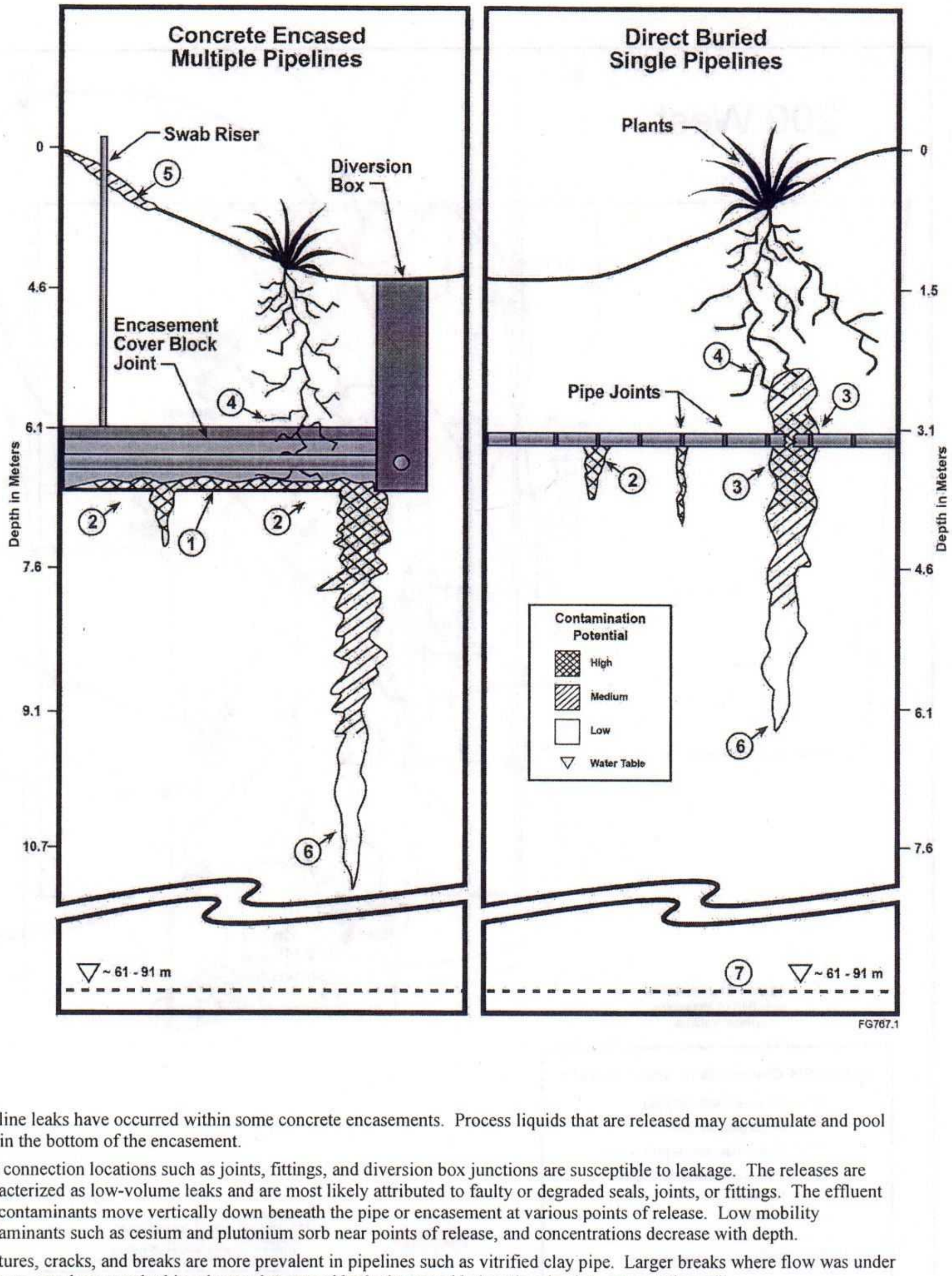
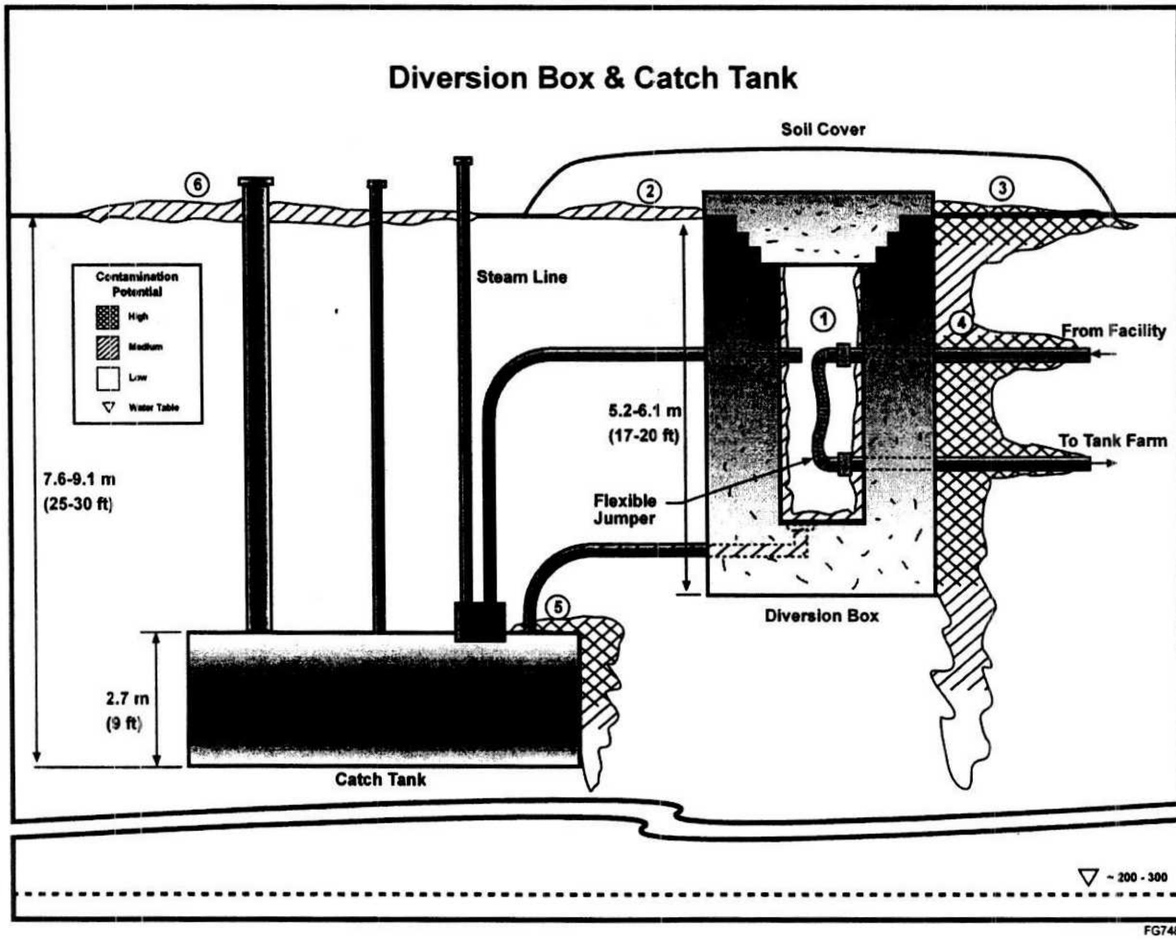
Figure 3-5. Conceptual Contaminant Distribution Model for Buried Process Pipelines.



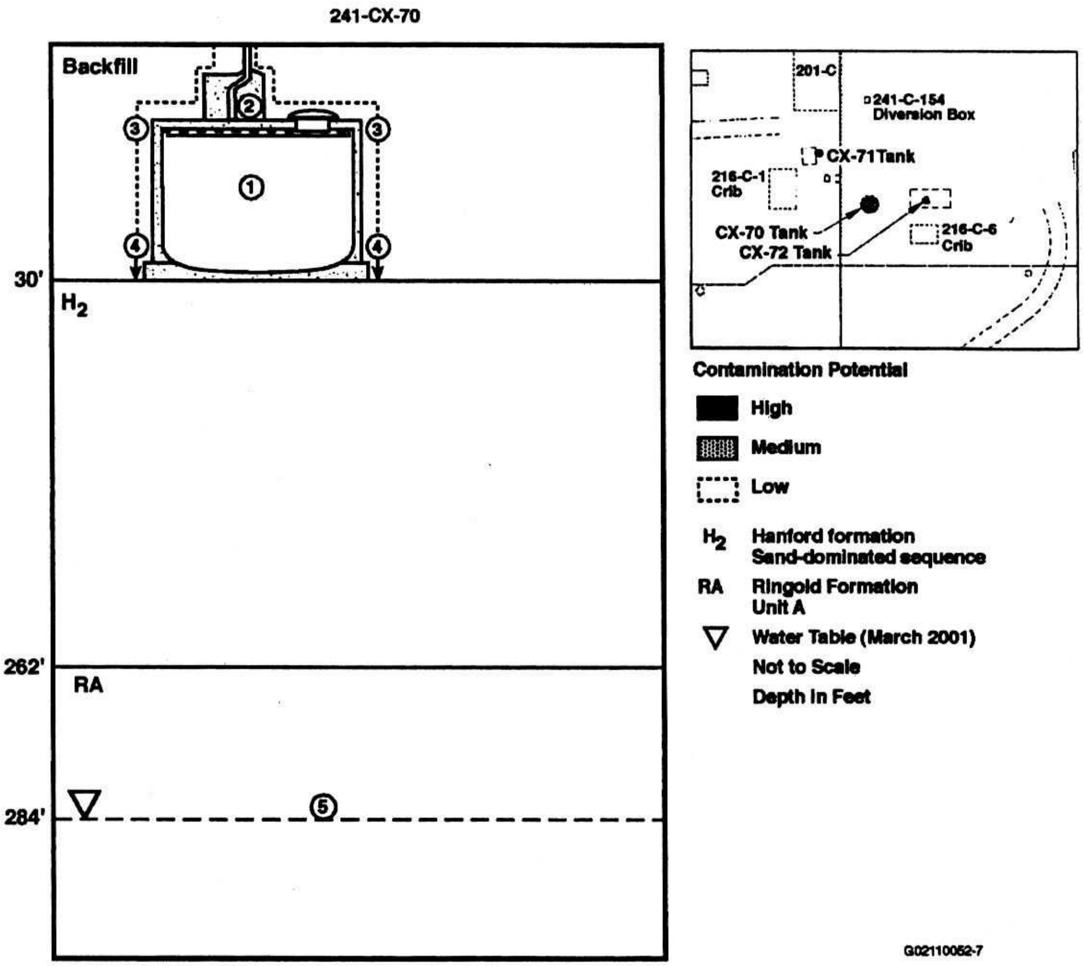
1. Pipeline leaks have occurred within some concrete encasements. Process liquids that are released may accumulate and pool within the bottom of the encasement.
2. Pipe connection locations such as joints, fittings, and diversion box junctions are susceptible to leakage. The releases are characterized as low-volume leaks and are most likely attributed to faulty or degraded seals, joints, or fittings. The effluent and contaminants move vertically down beneath the pipe or encasement at various points of release. Low mobility contaminants such as cesium and plutonium sorb near points of release, and concentrations decrease with depth.
3. Fractures, cracks, and breaks are more prevalent in pipelines such as vitrified clay pipe. Larger breaks where flow was under pressure may have resulted in releases that extend both above and below the pipe into surrounding soil.
4. Contamination extends above the pipeline to the surface in some places because of transport by vegetation (i.e., tumbleweeds).
5. Surficial dispersion of contaminants may occur around some swab risers caused by vent releases or sampling activities.
6. Mobile contaminants such as nitrate and tritium migrate with the moisture front to a maximum depth of 6.1 to 9.1 m (20 to 30 ft).
7. Process fluids and contaminants do not impact groundwater because the suspected volume of releases is small.

Figure 3-6. Conceptual Contaminant Distribution Model for a Diversion Box and Catch Tank.



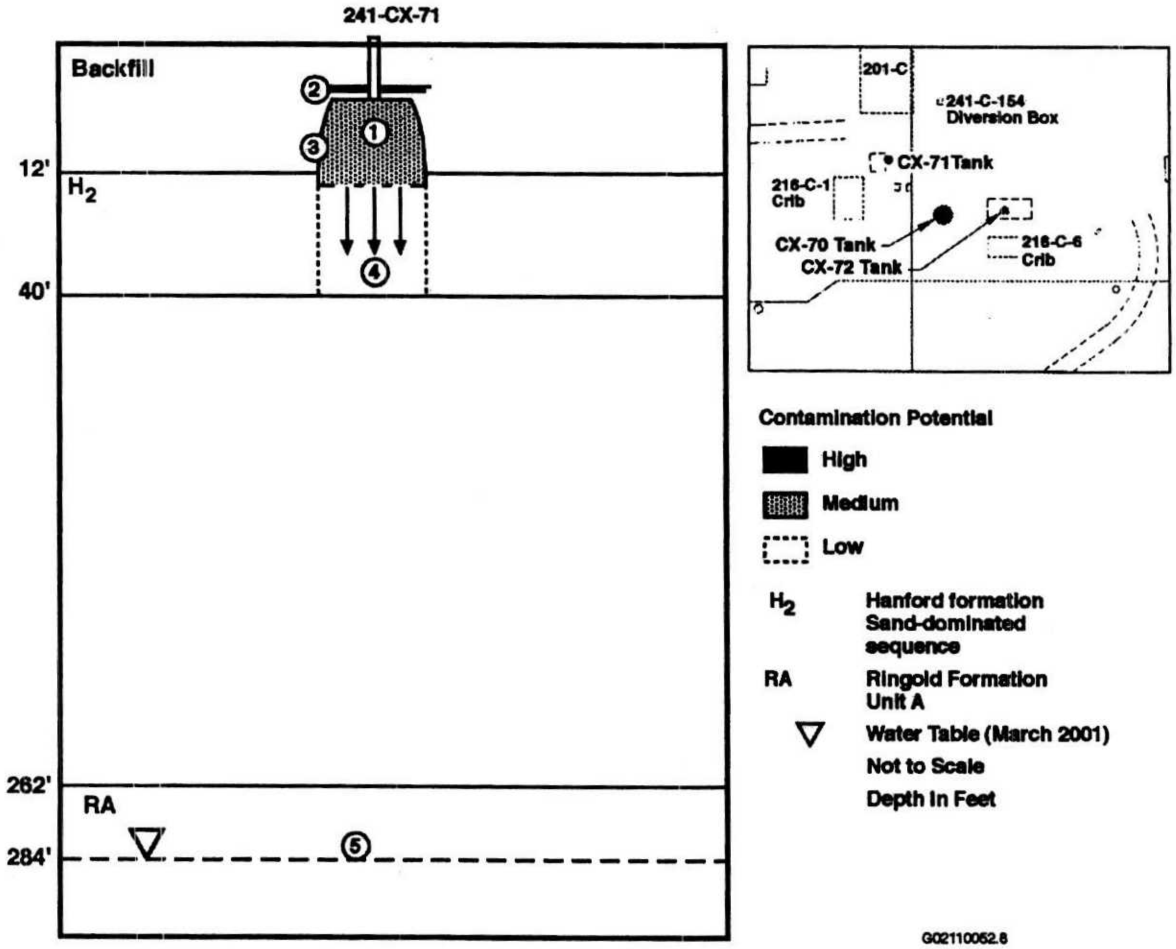
1. Leaks into the interior of the diversion box occurred when jumper connections were changed, or during a misrouting. Although most of the spill drained to the catch tank, some contamination remains on the interior floor or sides of the box.
2. During routing changeouts or maintenance activities, cover blocks were removed, exposing the diversion box interior to the environment. Winds, remote-handling activities, and removal of equipment generate unplanned releases on the ground surface around the structure. This is the most common type of unplanned release at these structures and is usually stabilized with a cover of clean soil. Vegetation or animal activities may remobilize the contamination.
3. During a misrouting, waste liquids fill the diversion box and flows onto the ground around the structure. The liquid drains into the soil and contaminants are distributed according to respective K_d values. Immobile contaminants such as plutonium and cesium remain close to the point of release; mobile contaminants such as technetium-99 and nitrate migrate with the moisture front. This type of unplanned release is very rare for these structures. The contaminated soil was covered with clean soil, shotcrete, or asphalt.
4. Pipe connections may fail at the diversion box exterior wall. Liquid is released to the soil column below ground and flows away from the break. Depending on the volume of the release, liquid flow may induce localized ground subsidence, with contaminated liquids emerging at the ground surface or in the depression (not shown). Contaminants are retained in the soil column according to respective K_d values. Immobile contaminants such as plutonium and cesium remain close to the point of release; mobile contaminants such as technetium-99 and nitrate migrate with the moisture front. This type of unplanned release is very rare. The area of surface contamination was covered with clean soil, shotcrete, asphalt, or other material.
5. Failure at a pipe fitting, or of the tank itself, leads to a loss of waste to the subsurface. Volume of waste lost is assumed to be low as most releases to catch tanks are assumed to be the sum of multiple jumper contents lost when routings were broken. Liquids move down through the soil column while contaminants are retained in the soil according to respective K_d values. Immobile contaminants such as plutonium and cesium remain close to the point of release; mobile contaminants such as technetium-99 and nitrate migrate with the moisture front. This type of failure is rare, but several replacement catch tanks have been installed at diversion boxes.
6. Surface releases around catch tank risers occur primarily when access to the tank is required for liquid-level measurement, sampling, or pumping. Opening the system to the environment allows vapors to escape or wind to mobilize contaminants in the riser. Sampling devices and pumps lowered into the tank to remove liquids entrain contaminants to the surface when removed and is scattered by leaks, drips, or wind. Rarely, overflows at diversion box/catch tank pairs led to releases through catch tank risers. Liquids move down through the soil column while contaminants are retained in the soil according to respective K_d values. Immobile contaminants such as plutonium and cesium remain close to the point of release; mobile contaminants such as technetium-99 and nitrate migrate with the moisture front. Releases are covered with clean soil to prevent spread of the radionuclides.

Figure 3-7. 241-CX-70 Storage Tank Conceptual Contaminant Distribution Model.



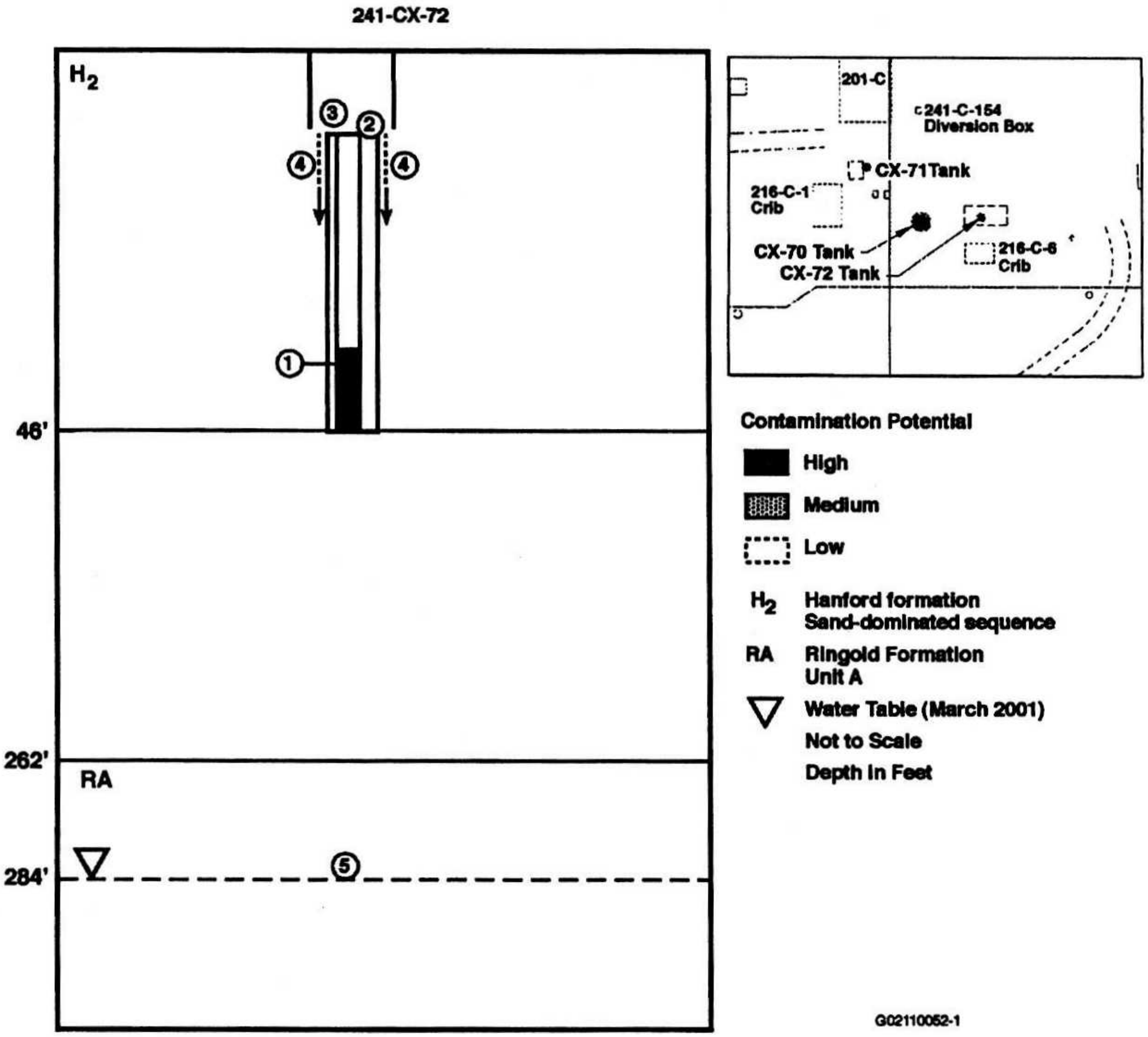
1. High-level process waste containing plutonium-239/240, cesium-137, strontium-90, sodium nitrate, sodium nitrite, sodium fluoride, aluminum sulfate, and sodium chromate were received by the tank from late 1952 to late 1953. The tank capacity was 113,550 L (30,000 gal). The tank received a total volume of 94,951 L (25,086 gal) of liquid waste. In 1979, 1987, and 1992, the liquid waste and sludge were sluiced/pumped from the tank. In 1992, the tank was dried and considered empty. Very little data are available to evaluate contaminant distribution at this site.
2. Potential leaks from this tank seem unlikely because of liquid-level measurements, volume of liquid waste received, and construction of tank. Therefore, if a leak had occurred, it would be more likely from process piping connecting to the tank, rather than the tank. To fulfill the conceptual contaminant distribution model, a leak of 0.1%, or 95 L (25 gal) is assumed to have been released from the process piping connecting to the tank. Based on this assumption, little or no lateral spreading is thought to have occurred because of the nature of soils under the site and the minimal amount of liquid released. Assuming that the spilled liquid was released within the soil adjacent to the tank, the entire assumed released amount would be retained by the soil within a 9-m (30-ft) radius of the tank.
3. Immobile contaminants, such as plutonium-239/240, normally sorb near the point of release. Contaminant concentrations decrease with depth.
4. Mobile contaminants such as nitrate migrate with the moisture front along and beneath the tank.
5. Wastewater and mobile contaminants likely have not impacted and are not likely to impact groundwater because the potential leak volume is significantly less than the soil column pore volume. While groundwater concentrations of iodine-129 exceed groundwater protection standards beneath the tank, this contamination is not attributed to this site.

Figure 3-8. 241-CX-71 Storage Tank Conceptual Contaminant Distribution Model.



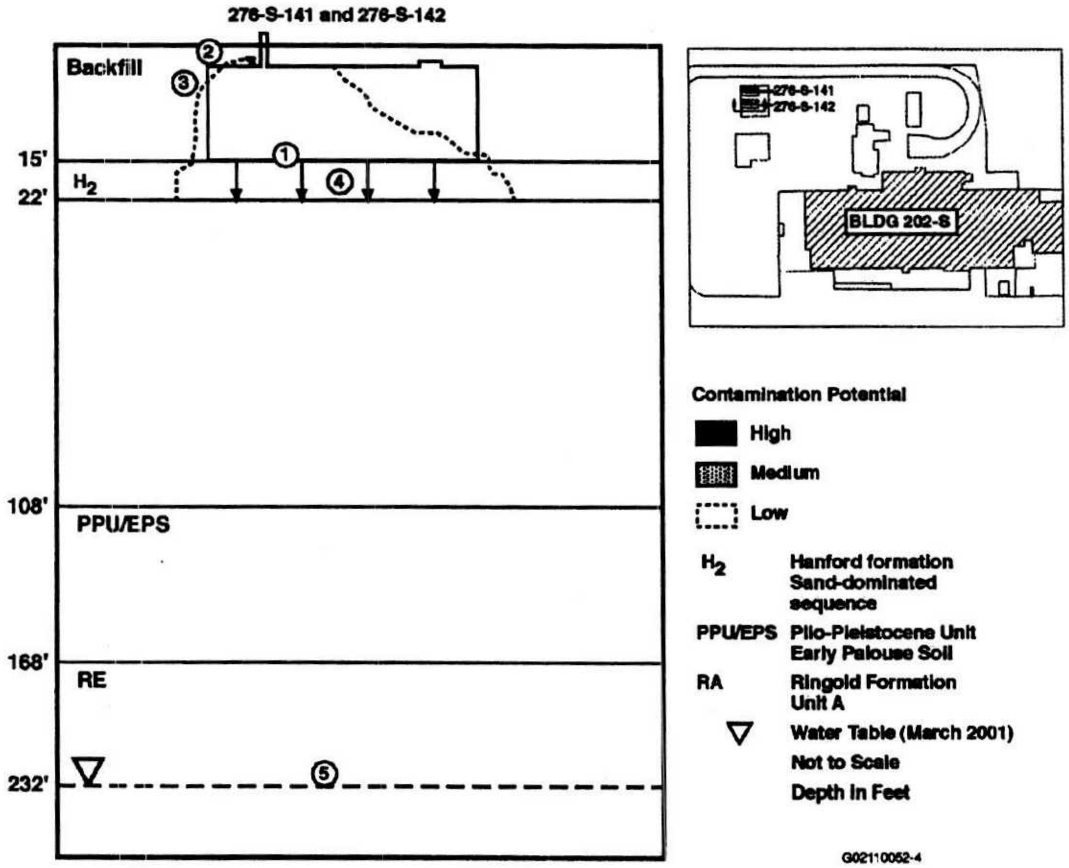
1. Process condensate waste containing plutonium-239/240, uranium, cesium-137, strontium-90, tributyl phosphate, caustic-tartrate, oxalic acid, hydrogen peroxide, sodium nitrate, sodium nitrite, sodium fluoride, aluminum sulfate, and sodium chromate were discharged to the tank from late 1952 until mid-1957. The tank's capacity was 3,807 L (1,000 gal). The tank transferred a total volume of 33,308,000 L (8.8 million gal) of liquid waste to C-1 and C-5 Cribs. In 1974, visual inspection indicated that the tank contained very little liquid and limestone. Very little data are available to evaluate contaminant distribution at this site.
2. Potential leaks from this tank are likely because of the volume of liquid waste received and similar leaks reported in other equipment in the Hot Semi-Works Building. For the purposes of this conceptual contaminant distribution model, a leak of 0.1 gal/hr is assumed over the time the tank was in service. Based on this assumption, a potential release of 8,300 L (2,200 gal) may have been released to the soil column. Based on this assumption and the nature of the soils near the waste site, little lateral spreading is expected to have occurred. Assuming that the spilled liquid was released within the soil adjacent to and beneath the tank, the entire assumed released amount would be retained by the soil within a 15-m (50-ft) radius of the tank.
3. Immobile contaminants, such as plutonium, normally sorb near the point of release. Contaminant concentrations decrease with depth.
4. Mobile contaminants such as nitrate migrate with the moisture front to depth.
5. Wastewater and mobile contaminants are not likely to have impacted groundwater because the potential leak volume is less than the soil column pore volume. While groundwater concentrations of iodine-129 exceed groundwater protection standards beneath the tank, the contaminant is not attributed to this site.

Figure 3-9. 241-CX-72 Storage Tank Conceptual Contaminant Distribution Model.



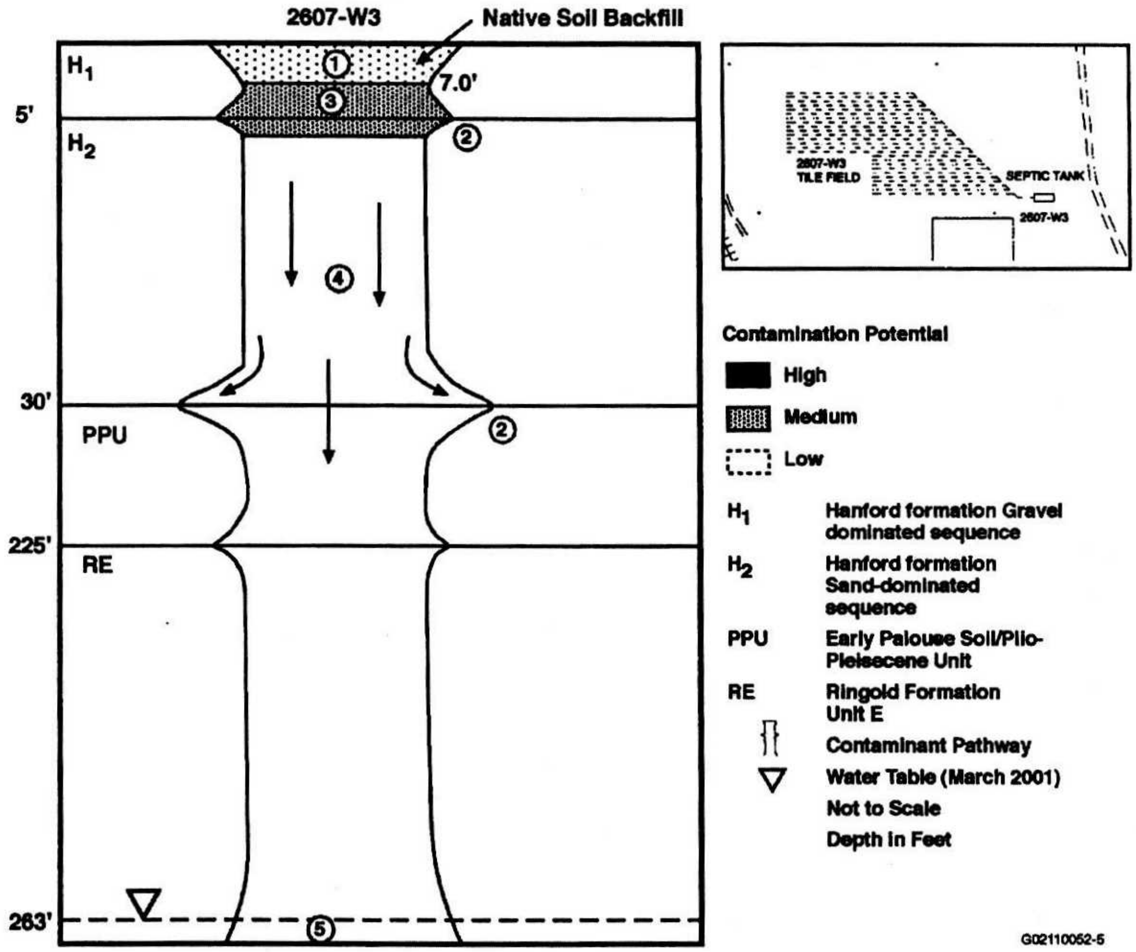
1. High-level process waste containing plutonium-239/240, uranium-total, tributyl phosphate, strontium-89/90 caustic-tartrate, oxalic acid, hydrogen peroxide, nitric ferrous ammonium sulfate, nitric dichromate, sodium nitrate, sodium nitrite, aluminum sulfate, sodium fluoride, and sodium chromate were received by the tank in 1956. The tank's capacity was 8,725 L (2,300 gal). The tank received 8,724 L (2,300 gal) of liquid waste. In 1974, the tank was reported as having approximately 1.9 m (74.5 in.) of waste. Very little data are available to evaluate contaminant distribution at this site.
2. Potential leaks from this tank seem unlikely because of liquid-level measurements, the volume of liquid waste received, and the construction of tank. Therefore, leaks, if any, would probably be from process piping connecting to the tank. For purposes of this conceptual contaminant distribution model, a leak of 1%, or 87 L (23 gal), is assumed to have been released from the process piping connecting to the tank. Based on this assumption, little or no lateral spreading is expected to have occurred based on the nature of soils associated with the waste site and minimal volume of liquid potentially released. Assuming this volume of liquid was released to soils adjacent the tank, it would be retained by soils within 1.3 m (4 ft) of the top of the tank.
3. Immobile contaminants such as plutonium normally sorb near the point of release. Contaminant concentrations decrease with depth.
4. Mobile contaminants such as nitrate migrate with the moisture front to depth.
5. Wastewater and mobile contaminants have not likely impacted and are not likely to impact groundwater, because the potential leak volume is less than the soil column pore volume. While groundwater concentrations of iodine-129 exceeds groundwater protection standards beneath the tank, this contaminant is not attributed to this site.

Figure 3-10. 276-S-141 and 276-S-142 Storage Tanks Conceptual Contaminant Distribution Model.



1. Essentially 100% hexone waste, containing minor amounts of uranium-238, strontium 89/90, cobalt 60, and cesium 137, was received by the tank. The tank's capacity was 89,000 L (23,575 gal). The tank received an estimated volume of 605,600 L (160,000 gal) of liquid waste. In 1991, pumpable liquids were removed from the tank leaving approximately 946 L (250 gal) of sludge. Very little data are available to evaluate contaminant distribution at this site.
2. Potential leaks from this tank are unlikely based on a tank integrity test. Therefore, if a leak had occurred, it would probably be from process piping connecting to the tank. For purposes of this conceptual contaminant distribution model, a leak of 0.05 gal/hr, or 4,800 L (1,300 gal), is assumed to have been potentially released from the process piping connecting the tank. Based on this assumption, little lateral spreading is expected to have occurred based on the nature of soils near the waste site. Assuming this volume of liquid was released to soils adjacent the tank, it would be retained by soils within 6.7 m (22 ft) beneath the tank.
3. Immobile contaminants such as cesium-137 normally sorb near the point of release. Contaminant concentrations decrease with depth.
4. Mobile contaminants such as hexone migrate with the moisture to depth.
5. Wastewater and mobile contaminants likely have not impacted and are not likely to impact groundwater because the potential leak volume is less than the soil column pore volume. While groundwater concentrations of iodine-129 exceed groundwater protection standards beneath the tank, this contamination is not associated with the site.

Figure 3-11. 2607-W3 Septic Tank Conceptual Contaminant Distribution Model.



1. Sanitary sewage containing cleaning products, soaps, boric acid, oxalic acid, EDTA, phosphoric acid, and ammonium hydroxide were discharged to the septic tank and drain field from 1944 to 1996. A potential for slight contamination exists if radionuclides were discharged to the septic tank through a sink or toilet from contaminated clothing or personnel. Likely isotopes would include plutonium-239/224, americium-241, cesium-137, strontium-90, and cobalt-60. The septic system is estimated to have received a total of 250,000,000 L (66,000,000 gal) of wastewater. Very few data are available to evaluate contaminant distribution at this site.
2. Once discharged, wastewater and contaminants migrate vertically downward beneath the drain field within H1. Lateral spreading probably occurs; however, this is not supported by borehole data. The nearest well is 299-W11-7, located approximately 21 m (70 ft) to the southwest. Wastewater and contaminants may be associated with this unit. Effluent and more mobile contaminants intersect the PPU at approximately 32 m (105 ft) bgs. Minor spreading of contaminants may occur associated with this unit. Effluent and more mobile contaminants intersect the Ringold Unit E at approximately 42.7 m (40 ft) bgs. Lateral spreading of contaminants may occur with this unit.
3. Immobile contaminants such as cesium-137 normally sorb near the point of release. Contaminant concentrations decrease with depth.
4. Mobile contaminants such as nitrate migrate with moisture front beneath the drain field and may be detected in low concentration to the water table.
5. Wastewater and contaminates may affect groundwater since the effluent discharge to the soil column is greater than the soil column pore volume. While groundwater concentrations of tritium, iodine-129, trichloroethylene, carbon tetrachloride, and nitrate exceed groundwater protection standards beneath the drain field, only nitrate may have been associated with waste disposal practices at this septic system.

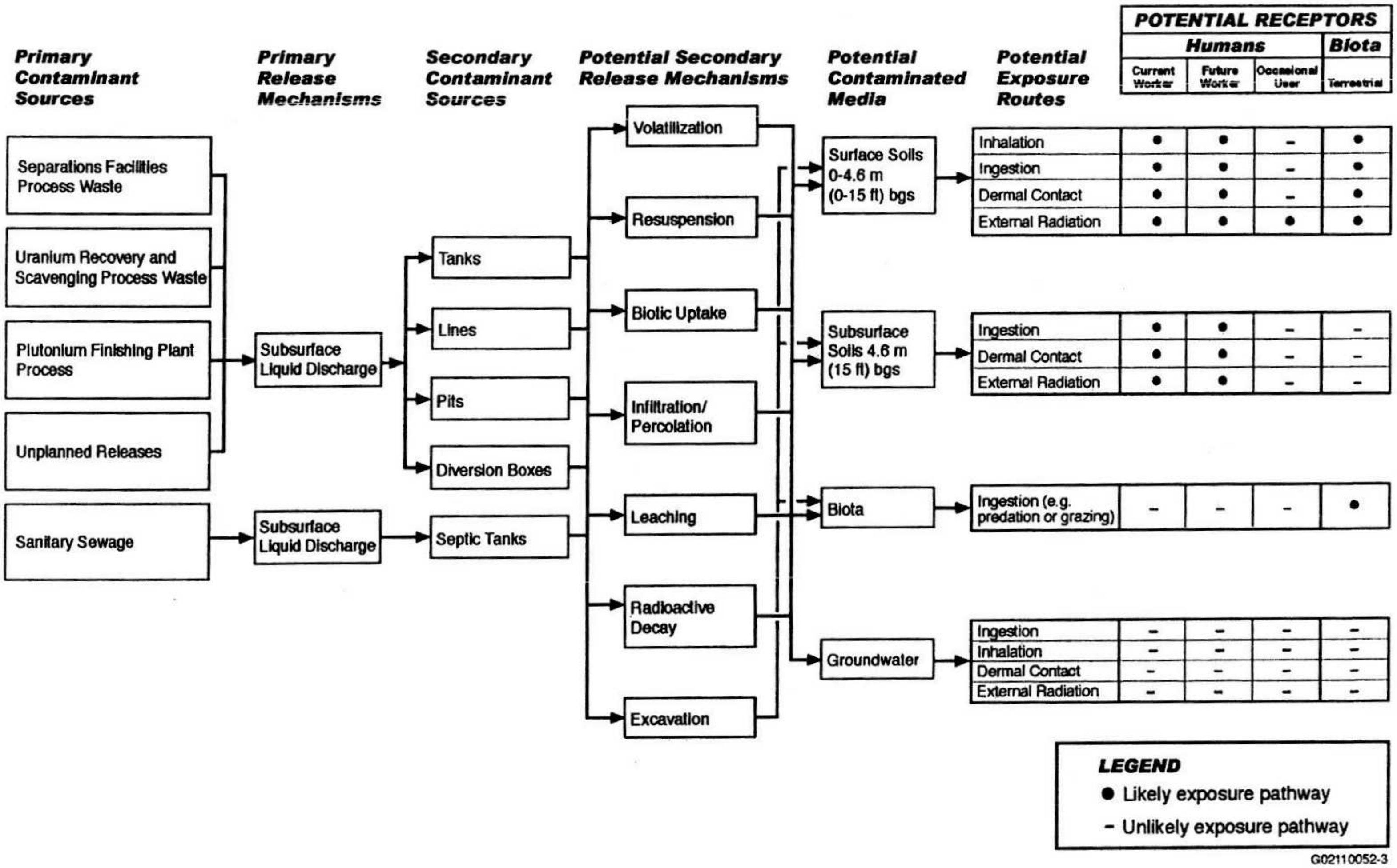


Figure 3-12. Conceptual Exposure Pathway Model.

Table 3-1. Detectable Metal Concentrations in Vegetation at the 216-U-8 Vitrified Clay Pipeline and 216-U-8 Crib (BHI-00033).

		Metals (mg/kg)													
	Sample ID	[illegible]	[illegible]	Ba[a]	Ca	Cu[a]	[illegible]	[illegible]	Mg	Mn	K	Na	[illegible]	[illegible]	Zn
216-U-8 vitrified clay pipeline	BOBFL8	192	11.6(B)	27.3(B)	21,400	6.2	278	0.47(B)	5,990	25.7	4,140	(U)	19.1	(U)	(U)
	BOBFL9	(U)	(U)	33.9(B)	28,900	7.6	298	(U)	8,160	41.6	4,740	(U)	19.7	(U)	(U)
	BOBFM0	419	15.8	18.9(B)	19,900	6.9	830	0.75	4,510	59.5	1,740	(U)	57.4	(U)	34
	BOBFM1	578	(U)	27.7(B)	20,800	4.1(B)	1,110	0.7	3,470	48.2	1,130	(U)	80.9	2.9(B)	U
	BOBFM2	226	(U)	22.3	15,400	12.2	433	1	4,530	37.1	8,390	161(B)	32.3	(U)	20.4
	BOBFM3	274	12.3(B)	19.9(B)	15,600	7.9	534	0.55(B)	5,850	41.3	5,360	(U)	40.2	(U)	(U)
	Maximum	578	15.8	33.9	28,900	12.2	1,110	1	8,160	59.5	8,390	161	80.9	2.9	34
	Minimum	192	11.6	18.9	15,400	4.1	278	0.47	3,470	25.7	1,130	161	19.1	2.9	20.4
	Avg. detectable concentration	337.8	13.2	25	20,333.3	7.48	580.5	0.694	5,418.3	42.2	4,250	161	41.6	2.9	27.2

		Metals (mg/kg)											
	Sample ID	[illegible]	[illegible]	Ca	Cr[a]	Co	Cu	[illegible]	[illegible]	Mn	K	[illegible]	[illegible]	Zn
216-U-8 Crib	BOBKN1	110	7.2(B)	2,630	(U)	(U)	5.6	226	1,600	11.5	5,930	16.8	(U)	(U)
	BOBKN2	1,280	25(B)	7,800	(U)	(U)	9.7	2,730	2,220	72.1	4,840	191	6.2(B)	16.2
	BOBKN3	96.6	4.4(B)	2,710	(U)	(U)	6	182	1,020	18	5,410	12.8	(U)	10.1
	BOBKN4	1,870	34.4(B)	10,100	2.5	2(B)	11.7	4,150	2,260	154	2,950	292	9.2(B)	33.3
	Maximum	1,870	34.4	10,100	2.5	2	11.7	4,150	2,260	154	5,930	292	6.2	33.3
	Minimum	96.6	4.4	2,630	2.5	2	5.6	182	1,020	11.5	2,950	12.8	9.2	10.1
	Avg. detectable concentration	839.2	17.8	5,810	2.5	2	8.25	1,822	1,775	63.9	4,782.5	128.2	7.7	19.9

[a] Contaminant of concern for the 200-PW-2 Operable Unit. BHI-00033, *Surface and Near-Surface Field Investigation Data Summary Report for the 200-UP-2 Operable Unit.*

Qualifiers: (U) = undetected; (B) = analyte found in sample blank; (J) = concentration is estimated.

Undetected metals: As, Be, Cd, Se, Ag, Tl, Hg, and Ni.

Table 3-2. Detectable Radionuclide Concentrations in Vegetation at the 216-U-8 Vitrified Clay Pipeline and 216-U-8 Crib (BHI-00033).

	Radionuclides (pCi/g)																			
	Sample ID	[illegible]	[illegible]	[illegible]	[illegible]	K-40	Pb-212	Pb-214	Pu-239/240	[illegible]	[illegible]	[illegible]	Th-232	Th-234	Tl-208	Total [illegible]	U-234	[illegible]	[illegible]	Total U
216-U-8 vitrified clay pipeline	BOBFL8	(U)	1.89	817	0.158	9.28	0.024	NA	(U)	NA	NA	296	NA	NA	NA	328	0.0554	0.0474	NA	0.209
	BOBFL9	NA	2.7	4,220	0.974	5.37	0.219	0.193	0.0708	0.234	2.66	117	0.185	NA	0.0425	1,380	0.198	0.189	0.193	0.752
	BOBFM0	NA	2.3	879	17.2	3.67	0.0643	NA	0.0228	0.0686	1.44	49.5	0.152	NA	NA	492(J)	0.324	0.299	NA	0.782
	BOBFM1	NA	2.21	614	6.32	3.43	0.0463	NA	(U)	0.0494	1.85	46.8	0.118	NA	0.037	426(J)	0.186	0.145	NA	0.613
	BOBFM2	0.0414	2.02	24.8	0.579	5.29	0.0451	0.134	0.0239	0.0423	(U)	29.4	NA	NA	NA	10.4	(U)	(U)	0.134	0.126
	BOBFM3	(U)	2.61	35.4	0.611	3.58	0.0448	NA	(U)	0.0479	(U)	28.7	NA	2.63	0.00774	10(J)	0.08	(U)	NA	0.106
	Maximum	0.0414	2.7	4,220	17.2	9.28	0.219	0.193	0.0708	0.234	2.66	296	0.185	2.63	0.0425	1,380	0.324	0.299	0.193	0.782
	Minimum	0.0414	1.89	24.8	0.158	3.43	0.024	0.134	0.0228	0.0423	1.44	28.7	0.118	2.63	0.0077	10	0.0554	0.0474	0.134	0.106
	Avg. detectable concentration	0.0414	2.3	1,098.4	4.307	5.1	0.0739	0.1635	0.0392	0.0884	2.0	94.6	0.1517	2.63	0.0291	441.1	0.1687	0.1701	0.1635	0.4313

	Radionuclides (pCi/g)																			
	Sample ID	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	K-40	Pb-212	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Th-232	Th-234	Tl-208	[illegible]	[illegible]	[illegible]	U-238G
216-U-8 Crib	BOBKN1	(U)	(U)	1.57	117	0.118	6.37	0.0428	NA	(U)	0.0446	(U)	5.34	0.0446	NA	0.0106	523(J)	0.0484	(U)	NA
	BOBKN2	7.42	0.0202	NA	235	1.67	6.78	0.257	0.471	0.0748	0.268	(U)	23.5	0.464	NA	0.165	295(J)	0.104	0.134	0.471
	BOBKN3	(U)	(U)	2.58	721	0.0723	6.65	0.0128	NA	(U)	0.0133	1.21	36.1	NA	NA	0.00933	66.9(J)	0.0491	0.0629	NA
	BOBKN4	5.88	(U)	1.8	417	1.11	5.27	0.289	NA	(U)	0.301	U	45.5	NA	18.4	NA	491(J)	0.255	0.191	NA
	Max	7.42	0.0202	2.58	721	1.67	6.78	0.289	0.471	0.0748	0.301	1.21	45.5	0.0464	18.4	0.165	523	0.255	0.191	0.471
	Min	5.88	0.0202	1.57	117	0.0723	5.27	0.0128	0.471	0.0748	0.0133	1.21	5.34	0.0446	18.4	0.0093	66.9	0.0484	0.0629	0.471
	Avg. detectable concentration	6.65	0.0202	1.98	372.5	0.7426	6.2675	0.1504	0.471	0.0748	0.1567	1.21	27.61	0.25	18.4	0.0616	344	0.1141	0.1293	0.471

[a] Contaminants of concern for 200-PW-2 Operable Unit. BHI-00033, *Surface and Near-Surface Field Investigation Data Summary Report for the 200-UP-2 Operable Unit.*
Qualifiers: (U) = undetected; (J) = concentration is estimated, NA = not analyzed.
Undetected radionuclides: Cm-242, Cm-244, Cs-134, Co-60, Eu-152, Eu-154, Eu-155, I-129, Na-22, Np-237, Pu-238, Ru-106, and U-235.

Table 3-3. Soil and Vegetation Concentrations of Radionuclides for the D021/V021 Monitoring Site Near the 200-W-59 Diversion Box.

Isotope	D021/V021 Monitoring Site	
	Soil (D021)	Vegetation (V021)
Antimony-125	2.9E-03	1.5E-02
Cerium-144	-4.3E-03	5.9E-02
Cobalt-60	5.3E-03	1.8E-02
Cesium-134	2.5 E-02	-1.3E-02
Cesium-137	2.1E-01	9.2E-03
Europium-152	-2.6E-02	3.7E-02
Europium-154	6.8E-03	-1.7E-02
Europium-155	5.0E-02	7.1E-03
Plutonium-238	-9.6E-02	6.4E-03
Plutonium-239/240	2.0E-02	3.7E-03
Ruthenium-103	-7.6E-03	1.9E-02
Ruthenium-106	5.2E-02	4.2E-03
Strontium-90	1.9E-01	4.7E-01
Tin-113	-9.5E-03	-5.3E-02
Uranium-234	1.9E-01	2.0E-02
Uranium-235	3.5E-02	3.8E-03
Uranium-238	1.7E-01	1.3E-02
Zinc-65	-5.2E-03	7.0E-02

Source: PNNL-13230, *Hanford Site Near-Facility Environmental Monitoring Data Report for Calendar Year 1999.*

Table 3-4. 200-IS-1 and 200-ST-1 Operable Unit Contaminants of Concern List. (5 sheets)

Contaminant	CAS Number	Chemical Process	References
Radionuclides			
Americium-241	14596-10-2	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	LA-UR-96-3860, WHC-SD-WM-ER-133, ORNL/TM-13391
Antimony-125	14234-35-6	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	Parrington 1996
Carbon-14	14762-75-5	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	LA-UR-96-3860, WHC-SD-WM-ER-133
Cesium-134	13967-70-9	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	Parrington 1996
Cesium-137	10045-97-3	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; WHC-SD-WM-ER-133, ORNL/TM-13141
Cobalt-60	10198-40-0	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; WHC-SD-WM-ER-133; WHC-MR-0270; ORNL/TM-13141
Europium-152	14683-23-9	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; HNF-1744
Europium-154	15585-10-1	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; HNF-1744
Europium-155	14391-16-3	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; WHC-SD-WM-ER-133
Hydrogen-3 (tritium)	10028-17-8	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	LA-UR-96-3860, WHC-SD-WM-ER-133
Iodine-129	15046-84-1	REDOX, PUREX/URP	HW-18700, HW-31000-DEL
Neptunium-237	13994-20-2	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	LA-UR-96-3860, WHC-SD-WM-ER-133
Nickel-63	13981-37-8	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	LA-UR-96-3860, WHC-SD-WM-ER-133
Plutonium-238	13981-16-3	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C
Plutonium-239/240	15117-48-3/ 14119-33-6	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; DOE-ORNL 1995
Radium-226	13982-63-3	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	LA-UR-96-3860, WHC-SD-WM-ER-133, RADDECAY Version 3
Radium-228	15262-20-1	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	LA-UR-96-3860, WHC-SD-WM-ER-133, RADDECAY Version 3
Strontium-90	10098-97-2	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	ORNL/TM-13141
Technetium-99	14133-76-7	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; WHC-MR-0270; ORNL/TM-13141
Thorium-232	7440-29-1	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; HNF-1744
Uranium-233/234	13968-55-3/ 13966-29-5	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; ORNL/TM-13141

Table 3-4. 200-IS-1 and 200-ST-1 Operable Unit Contaminants of Concern List. (5 sheets)

Contaminant	CAS Number	Chemical Process	References
Uranium-235/236	15117-96-1/ 13982-70-2	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C
Uranium-238	7440-61-1	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; ORNL/TM-13141
Metals			
Aluminum	7429-90-5	Bismuth phospate, REDOX, PUREX/URP, strontium/cesium operations, Z Plant complex	HW-10475, Parts A, B, and C; DOE/RL-91-58
Antimony	7440-36-0	REDOX	HW-18700
Arsenic	7440-38-2	Z Plant complex	FH-000279
Arsenic (III)	22569-72-8	N/A	Table 749-3, Ecology
Arsenic (V)	17428-41-0	N/A	Table 749-3, Ecology
Barium	7440-39-3	REDOX, strontium/cesium operations	HW-18700, ISO-100
Beryllium	7440-41-7	REDOXPUREX/URP	HW-18700, HW-31000-DEL
Cadmium	7440-43-9	Bismuth phospate	HW-10475, Part A
Chromium	7440-47-3	Bismuth phospate, strontium/cesium operations	HW-10475, Part C; WHC-MR-0132; ISO-100
Chromium (VI)	18540-29-9	Bismuth phospate, strontium/cesium operations	HW-10475, Part C; WHC-MR-0132, ISO-100
Cobalt	7440-48-4	Scavenging operations	LA-UR-96-3860, WHC-SD-WM-ER-133
Copper	7440-50-8	Bismuth phospate, REDOX, strontium/cesium operations	HW-10475, Part A; HW-18700; ISO-100
Lead	7439-92-1	Bismuth phospate, strontium/cesium operations	HW-10475, Parts A, B, and C; ISO-100
Lithium	7439-93-2	Z Plant complex	DOE/RL-91-58
Manganese	7439-96-5	Bismuth phospate, REDOX, PUREX/URP, Z Plant complex	HW-10475, Parts A, B, and C; HW-18700; HW-31000-DEL; DOE/RL-91-58
Mercury (inorganic)	7439-97-6	Bismuth phospate, REDOX, PUREX/URP	LA-UR-96-3860; HW-10475, Parts A, B, and C; HW-18700; HW-31000-DEL
Molybdenum	7439-98-7	Bismuth phospate	HW-10475, Parts A, B, and C
Nickel	7440-02-0	Bismuth phospate	LA-UR-96-3860, WHC-SD-WM-ER-133
Selenium	7782-49-2	Z Plant complex	FH-000279
Silver	7440-22-4	Bismuth phospate, REDOX, PUREX/URP, strontium/cesium operations, Z Plant complex	HW-10475, Part C; HW-18700; HW-31000-DEL; ISO-100; FH-000279
Strontium	7440-24-6	Bismuth phospate, REDOX, PUREX/URP, strontium/cesium operations	HW-10475, Part C; HW-18700; HW-31000-DEL; ISO-100; FH-000279
Thallium		PUREX	DOE/RL-2000-35
Tin	7440-31-5	Bismuth phospate, REDOX, PUREX/URP	HW-10475, Part C; HW-18700; HW-31000-DEL
Uranium	7440-61-1	Bismuth phospate, REDOX, PUREX/URP	HW-10475, Part C; HW-18700; HW-31000-DEL
Vanadium	7440-62-2	Bismuth phospate	HW-10475, Parts A, B, and C
Zinc	7440-66-6	Bismuth phospate	HW-10475, Parts A, B, and C

Table 3-4. 200-IS-1 and 200-ST-1 Operable Unit Contaminants of Concern List. (5 sheets)

Contaminant	CAS Number	Chemical Process	Reference
General Inorganics			
Ammonia/ammonium	7664-41-7	Bismuth phospate, REDOX, PUREX/URP, strontium/cesium operations	HW-10475, Part C; HW-18700; HW-31000-DEL; ISO-100
Chloride	16887-00-6	Bismuth phospate, REDOX, PUREX/URP, strontium/cesium operations, Z Plant complex	HW-10475, Part C; HW-18700; HW-31000-DEL, ISO-100, FH-000279
Cyanide	57-12-5	Scavenging operations	LA-UR-96-3860, WHC-SD-WM-ER-133
Fluoride	16984-48-8	Bismuth phospate, REDOX, PUREX/URP, strontium/cesium operations, Z Plant complex	HW-10475, Part C; HW-18700; HW-31000-DEL; ISO-100; WHC-SD-WM-ER-133; discussion/publications by Thurman D. Cooper, PFP Chemist
Iodine	7553-56-2	Z Plant complex	DOE/RL-91-58
Nitrate/nitrite	14797-55-8/ 14797-65-0	Bismuth phospate, REDOX, PUREX/URP, strontium/cesium operations, Z Plant complex	HW-10475, Part C; HW-18700; HW-31000-DEL; ISO-100; FH-000279
Phosphate	14265-44-2	Bismuth phospate, REDOX, PUREX/URP, strontium/cesium operations, Z Plant complex	HW-10475, Part C; HW-18700; HW-31000-DEL; ISO-100; FH-000279
Sulfate/sulfite	14808-79-8/ 14265-45-3	Bismuth phospate, REDOX, PUREX/URP, strontium/cesium operations, Z Plant complex	HW-10475, Part C; HW-18700; HW-31000-DEL; ISO-100; FH-000279
Organics			
1,1-dichloroethane (DCA)	75-34-3	Z Plant complex	WHC-SD-EN-TI-248
1,1-dichloroethene	75-35-4	Z Plant complex	WHC-SD-EN-TI-248
1,1,1-trichloroethane (TCA)	71-55-6	Z Plant complex	WHC-SD-EN-TI-248
1,1,2-trichloroethane	79-00-5	Z Plant complex	WHC-SD-EN-TI-248
1,1,2,2-tetrachloroethane	79-34-5	Z Plant complex	WHC-SD-EN-TI-248
1,2-dichlorobenzene	95-50-1	Z Plant complex	WHC-SD-EN-TI-248
1,2-dichloroethane (DCA)	107-06-2	Z Plant complex	WHC-SD-EN-TI-248
1,3-dichlorobenzene	541-73-1	Z Plant complex	WHC-SD-EN-TI-248
2,4-dinitrotoluene	121-14-2	Z Plant complex	WHC-SD-EN-TI-248
2-butanone (methyl ethyl ketone/MEK)	78-93-3	PUREX/URP, Z Plant complex	WHC-EP-0342, Addendum 12, Addendum 14, and Addendum 19; WHC-SD-EN-TI-248
2-hexanone	591-78-6	Z Plant complex	WHC-SD-EN-TI-248
Benzene	71-43-2	Z Plant complex	WHC-SD-EN-TI-248
Benzo[a]anthracene	56-55-3	PUREX	DOE/RL-2000-35
Benzo[a]pyrene	50-32-8	PUREX	DOE/RL-2000-35
Benzo[b]fluoranthene	205-99-2	PUREX	DOE/RL-2000-35
Benzo[k]fluoranthene	207-08-9	PUREX	DOE/RL-2000-35
Butanol	71-36-3	PUREX/URP	WHC-EP-0342, Addendum 12, Addendum 14, and Addendum 19
Carbon tetrachloride	56-23-5	Z Plant complex	WHC-SD-EN-TI-248
Chlorobenzene	108-90-7	Z Plant complex	WHC-SD-EN-TI-248

Table 3-4. 200-IS-1 and 200-ST-1 Operable Unit Contaminants of Concern List. (5 sheets)

Contaminant	CAS Number	Chemical Process	Reference
Chloroform	67-66-3	Z Plant complex	WHC-SD-EN-TI-248
Chrysene	218-01-9	PUREX	DOE/RL-2000-35
Cis-1,2-dichloroethylene	156-59-2	Z Plant complex	WHC-SD-EN-TI-248
Dibenz[a,h]anthracene	53-70-3	PUREX	DOE/RL-2000-35
Dichloromethane (methylene chloride)	75-09-2	Z Plant complex	WHC-SD-EN-TI-248
Ethyl benzene	100-41-4	Z Plant complex	WHC-SD-EN-TI-248
Indeno[1,2,3-cd]pyrene	193-39-5	PUREX	DOE/RL-2000-35
Methyl isobutyl ketone (MIBK/hexone)	108-10-1	REDOX, Z Plant complex	HW-18700, WHC-SD-EN-TI-248
Naphthalene	91-20-3	PUREX/URP, Z Plant complex	WHC-EP-0342, Addendum 12, Addendum 14, and Addendum 19; WHC-SD-EN-TI-248
n-butyl benzene	104-51-8	Z Plant complex	WHC-SD-EN-TI-248
Tetrachloroethylene (PCE)	127-18-4	Z Plant complex	WHC-SD-EN-TI-248
Toluene	108-88-3	PUREX/URP, Z Plant complex	WHC-EP-0342, Addendum 12, Addendum 14, and Addendum 19; WHC-SD-EN-TI-248
Trans-1,2-dichloroethene	156-60-5	Z Plant complex	WHC-SD-EN-TI-248
Trichloroethylene (TCE)	79-01-6	Z Plant complex	WHC-SD-EN-TI-248
Xylene	1330-20-7	PUREX/URP, Z Plant complex	WHC-EP-0342, Addendum 12, Addendum 14, and Addendum 19; WHC-SD-EN-TI-248
Total petroleum hydrocarbons (TPH)	68334-30-5	PUREX	DOE/RL-2000-35
Semi-Volatile Organics			
2-methylphenol (o-cresol)	95-48-7	Misc equipment oils and lubricants	CP-13196
4-methylphenol (p-cresol)	106-44-5	Misc equipment oils and lubricants	CP-13196
Normal paraffin hydrocarbons (n-dodecane)	112-40-3	PUREX/URP, strontium/cesium operations	WHC-SD-WM-ER-133, HW-31000-DEL, ISO-100
Phenol	108-95-2	Z Plant complex	WHC-SD-EN-TI-248
Polychlorinated biphenyls (PCBs)	1336-36-3	Bismuth phospate, Z Plant complex	HW-10475, Parts A, B, and C; discussions/publications with David A. Dodd, PFP Chemist

Table 3-4. 200-IS-1 and 200-ST-1 Operable Unit Contaminants of Concern List. (5 sheets)

Contaminant	CAS Number	Chemical Process	References
Petroleum			
Gasoline range organics	N/A	PUREX/URP, Z Plant complex	WHC-EP-0342, Addendum 12, Addendum 14, and Addendum 19; WHC-SD-EN-TI-248
Diesel range organics	68334-30-5	PUREX/URP, Z Plant complex	WHC-EP-0342, Addendum 12, Addendum 14, and Addendum 19; WHC-SD-EN-TI-248
Soil Properties			
Alkalinity	N/A	Tank farms	RPP-7578, Rev. 2
Conductivity	N/A	Tank farms	RPP-7578, Rev. 2
Gross alpha	14127-62-9	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; ORNL/TM-13391
Gross beta	12587-47-2	Bismuth phosphate, REDOX, PUREX/URP, Z Plant complex, strontium/cesium operations	HW-10475, Parts A, B, and C; ORNL/TM-13391
Gross gamma	N/A	Tank farms	RPP-7578, Rev. 2
Moisture content	N/A	Tank farms	RPP-16608, Rev. 0
pH	N/A	Tank farms	RPP-16608, Rev. 1
Total inorganic carbon	N/A	Tank farms	RPP-7578, Rev. 2
Total organic carbon	N/A	REDOX, PUREX/URP, strontium/cesium operations, Z Plant complex	HW-18700, HW-31000-DEL, ISO-100, DOE/RL-91-58

Any constituents measured by gamma energy analysis or inductively coupled plasma that are 5% of the analyses inventories or greater.

CAS = Chemical Abstract Service
N/A = not applicable
PUREX = plutonium-uranium extraction
REDOX = reduction-oxidation
URP = uranium recovery process

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PART II –

PIPELINES, DIVERSION BOXES, AND ASSOCIATED WASTE SITES

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PART II – PIPELINES, DIVERSION BOXES, AND ASSOCIATED WASTE SITES

4.0 APPROACH AND RATIONALE FOR PROCESS PIPELINES, DIVERSION BOXES, AND ASSOCIATED WASTE SITES

Part II of the work plan addresses the pipelines, diversion boxes, and associated waste sites within the 200-IS-1 OU (Appendix C). The work plan approach for these waste sites includes a strategy that optimizes use of the existing process knowledge and waste site characterization data available at Hanford. This includes integration of the results obtained from site investigations and remedial actions completed within the 100, 200, and 300 Areas. An extensive amount of waste site characterization data is available for liquid releases at Hanford. Data sources provide information on waste site attributes, including contaminant nature and extent. Results of previously completed characterization investigations and removal actions provide a framework within which to plan for the anticipated remedial activities that will be needed for the pipelines, diversion boxes, and associated waste sites within the 200-IS-1 OU. Section 4.0 describes how the pipelines, diversion boxes, and associate waste sites will be evaluated for future remedial decisions.

Site profiles have been developed that encompass all of the 200-IS-1 OU pipelines, diversion boxes, and associated waste sites, as well as similar waste sites in other OUs. Information pertaining to specific characteristics of pipelines, diversion boxes, and associated structures used to develop the site profiles is provided in this section.

Sixteen site profiles have been developed for the 200-IS-1 OU pipelines, diversion boxes, and associated waste sites. The profiles were developed to organize waste sites based on attributes that will be important in the evaluation conducted during the remedy selection process. Attribute information selected for use in defining waste site profiles includes the following:

- Radiological characteristics of the liquid waste streams handled by the structure. This attribute is categorized by radionuclide activity of the waste stream (i.e., low-, moderate-, and high-activity).
- The depth below ground surface at the base of the waste site structure (i.e., pipeline invert or diversion box bottom). This attribute is categorized by specifying whether the base of the structure is above or below a depth of 15 ft. The 15-ft depth has been selected because it is a potential point of compliance for direct human and ecological exposure to contaminants in soil.
- Known or suspected release(s) of contaminants from the structure to the surrounding soil. For some pipeline and diversion box waste sites, releases to the surrounding soil have been documented and are identified within the WIDS database as individual UPR sites.
- Presence of the pipeline within an encasement. This attribute is associated with major pipeline structures such as the 200 Area cross-site transfer line.

The 16 site profiles defined using these attributes are organized by waste stream radiological activities. The attributes selected to group a waste site with a site profile are presented in Table 4-1.

Using these attribute categories, the 200-IS-1 OU waste sites consisting of pipelines, diversion boxes, catch tanks, and associated UPRs that are currently documented in WIDS have been sorted and included with one of the 16 site profiles. Identification of the site profiles that are currently designated for each waste site is presented in Appendix F.

4.1 SUMMARY OF DATA QUALITY OBJECTIVE PROCESS

The RI needs for assessing potential human health impacts from pipelines, diversion boxes, and associated waste sites within the 200-IS-1 OU were developed in accordance with EPA's *Guidance for Data Quality Objectives Process* (EPA 600/R-96/055, EPA QA/G-4). The DQO process is a seven-step planning approach used to develop data collection strategies consistent with data uses and needs. The DQO goals for the 200-IS-1 OU were to provide the data needed to refine the preliminary conceptual contaminant distribution models and to support remedial decisions. The need for additional data to support the assessment of potential ecological impacts will be evaluated through a separate Central Plateau DQO process.

The DQO process was implemented by a team of subject matter experts and key decision makers who developed the characterization and data-gathering approach outlined in the DQO summary report. The subject matter experts provided input on regulatory issues, history, and physical condition of the sites, and sampling and analysis methods. The key decision makers were representatives from DOE and Ecology. Both the DQO process and the participants provide a high degree of confidence that the appropriate data are collected to provide the information needed to make good decisions about the 200-IS-1 OU. Results of the original DQO process for the 200-IS-1 OU are presented in CP-13196, *Remedial Investigation Data Quality Objectives Summary Report – 200-IS-1 and 200-ST-1 Operable Units.*

A second DQO process was initiated in the fall of 2004 to address the additional scope required by Ecology for this revised work plan. The second DQO process focused on the changes in the technical and regulatory approach that would be needed in order to include ORP-owned pipelines, diversion boxes, and associated waste sites located outside of the WMAs that are part of SST and DST waste transfer infrastructure. These 200-IS-1 OU waste sites had not been included in the scope of the previous work plan. The addition of these waste site resulted in development of an expanded list of COCs (discussed in Section 3.6), a revised characterization strategy, and a more comprehensive integration approach to fulfill RCRA and CERCLA regulatory requirements.

The initial DQO waste site review process completed in 2002 identified two representative waste sites for characterization of pipelines and diversion boxes within the 200-IS-1 OU. This initial approach to streamlining characterization requirements for waste sites within an OU is referred to as the "analogous site concept" in the 200 Areas Implementation Plan (DOE/RL-98-28). Because of the diversity in characteristics for pipelines, diversion boxes, and associated waste sites, this approach is not being proposed for these types of waste sites in this revision of the work plan. A new approach is proposed that is based on site attributes and development of site profiles that encompass all potential site conditions. Remedial evaluations performed during the FS can be made using the site profiles that have been developed. Contaminant distributions are expected to follow relatively predictable patterns based on process knowledge and existing environmental data.

4.1.1 Determination of Candidate Waste Sites for Remedial Investigation

The original set of waste sites assigned to the 200-IS-1 OU (DOE/RL-98-28) was based on the rationale that the OU was created for structures used to handle the high-level plant waste generated from separations or volume-reduction processes conducted outside of the tank farms and processing facilities. At the same time, it was recognized that remediation of some of these structures would ultimately be associated with tank farms stabilization. The initial strategy was to place diversion boxes, valve pits, sampler pits, pipelines, and other similar structures constructed in support of a soil column disposal waste site (e.g., trenches and cribs) within the OU in which the soil column disposal waste site had been placed. This waste transfer network includes a web of pipelines connecting facilities within and between the 200 East and 200 West Areas. At the time, the network was only partially identified in the WIDS database.

Subsequently, new waste sites have been assigned to the 200-IS-1 OU in accordance with RL-TPA-90-0001, *Tri-Party Agreement Handbook Management Procedures*, Guideline Number TPA-MP-14, "Maintenance of the Waste Information Data System (WIDS)." Up to the point of development of the work plan, neither the original sites nor those added since the publication of DOE/RL-98-28 had been screened to determine their appropriateness as candidates for completion of a RI/FS. As part of the DQO process and work plan development, all of the waste sites currently listed in WIDS and assigned to the 200-IS-1 OU were reviewed. This review included identifying those waste sites that would not require completion of the RI/FS process. Waste sites where sorted into groups based on regulatory requirements or to delineate site ownership and responsibilities.

The sites were sorted based on the following criteria:

- Categories defined in WIDS (e.g., "Classification Status Rejected Sites," "Classification Status Proposed Rejected Sites," etc.)
- Whether the sites were active
- Whether the sites were under the jurisdiction of other regulatory authority
- Which was the responsible DOE program (RL or ORP)
- Whether the sites were assigned to an appropriate waste group.

The WIDS database includes an assignment of waste site responsibility. The designated DOE organization (i.e., RL or ORP) has the responsibility for completion of characterization, remediation, and site closure activities for the assigned waste sites.

The results of this review are provided in Appendix C, Tables C-1 through C-5, and are summarized as follows:

- Table C-1: Includes all pipeline, diversion box, catch tank, and UPR waste sites identified with the 200-IS-1 OU as of September 2004.
- Table C-2: Includes all waste sites identified with the 200-IS-1 OU that are in the process of being removed or that have been removed from consideration in the RPP process. These reclassifications are supported by information provided to the Tri-Party Agreement reclassification team and require team approval before being removed.

- Table C-3: Includes those waste sites identified in Table C-1 that will not be considered in this work plan. These sites generally are proposed for inclusion with another OU or project.
- Table C-4: Includes all 200-IS-1 OU waste sites currently identified in WIDS that are the responsibility of ORP. This table addresses programmatic responsibility for waste sites associated with waste transfers within the SST and DST systems.
- Table C-5: Includes all pipelines, diversion boxes, and associated structure waste sites identified with the 200-IS-1 OU that currently are considered to be included in this work plan. This table is meant to reflect current site-tracking conditions as of September 2004 and is expected to change as the identification of new waste sites occurs (particularly pipelines) and the reassignment process continues.

4.1.2 Data Uses

Information concerning pipeline and diversion box structural characteristics, documented or suspected leakage, and waste streams handled will be used in the remedial alternative evaluation process. Acquisition of this data is ongoing and includes the identification of new waste sites. Documenting the locations of pipeline segments and the connections that occur between pipelines requires identifying and reviewing hundreds of historical engineering drawings. The complete delineation and mapping of all of the buried pipeline segments and diversion boxes in the 200 Areas is a major undertaking. It is estimated that over 200 mi of pipelines are associated with the 200 Area facility buildings and tank farms. Information concerning structural characteristics such as the pipeline's composition, age, depth of burial, and susceptibility for leakage (documented at some pipeline locations as UPR waste sites) is currently being compiled.

The composition of the fluids associated with any leakage that may have occurred will be initially assessed using historical waste transfer records from generation locations to storage locations (i.e., tank farms) or disposal locations (i.e., cribs and trenches). This process knowledge can be used to determine the waste streams handled by the structures. Hazards associated with certain waste stream constituents will be considered during the remedy selection process.

A comprehensive assessment of the pipelines and their attributes for the majority of the waste transfer network within the 200 Areas will be presented in the RI report. The data will be used in conjunction with other decision criteria during the remedial evaluation process conducted as part of the FS. The proposed strategy for identification of appropriate remedies based on pipeline attributes is presented in Section 5.3.

4.1.3 Data Needs

Sections 2.0 and 3.0 presented summary information concerning physical site characteristics and the extent of releases documented at some of the 200-IS-1 waste sites. This existing information was used to develop conceptual contaminant distribution models for the process pipelines and diversion box waste sites.

For many of the 200-IS-1 OU waste sites identified in WIDS, information is available concerning location, construction design, and composition of the liquid waste received or distributed through the structure. However, specific site conditions, such as residual contaminant levels inside pipelines or diversion boxes, extent of releases to surrounding soils, and current concentrations or activities for those contaminants that may be present, has not been determined for the majority of the pipeline network. What has been evaluated at this time is the probable range of contaminant conditions that may occur at the waste sites. Sufficient existing waste site data are available to bound the site conditions that are expected to be encountered. Specifically, the type, concentration (particularly the highest concentration), and the potential vertical distribution of radiological and nonradiological contamination expected to occur in the vadose zone.

Because of the anticipated variability in waste site characteristics, as indicated by the number of waste site profiles that have been developed, gathering additional characterization data will not benefit the remedy selection process. Therefore, the data needs identified for the proposed work plan approach more appropriately focus on compiling existing data that can be used in support of a decision logic for associating waste site characteristics with appropriate remedies.

Post-ROD confirmation data collected at selected locations will be used to substantiate that the waste site's characteristics are consistent with the attributes of the site profile prior to implementation of the preferred remedy. Additional discussion concerning matching of site conditions (i.e., attributes and site profiles) to appropriate remedies is presented in Section 5.3.

4.1.4 Data Quality

Data quality was addressed during the DQO process. Identification of the final list of COCs is summarized in Section 3.6. Analytical performance criteria were established by evaluating potential ARARs and preliminary remediation goals (PRGs), which are regulatory thresholds and/or standards or derived risk-based thresholds. These potential ARARs and PRGs represent chemical-, location-, and action-specific requirements that must be met to protect human health and ecological receptors. Regulatory thresholds and/or standards or preliminary action levels provide the basis for establishing cleanup levels and dictate analytical performance levels (i.e., laboratory detection limit requirements). Detection limit requirements and standards for precision and accuracy are used to define data quality.

To provide the necessary quality of data, detection limits should be lower than the preliminary action levels. Additional data quality is gained by establishing specific policies and procedures for generating analytical data, field quality assurance, and quality control requirements. Analytical performance requirements are specified in Table B-4 (Appendix B). The preliminary assessment of potential ARARs and PRGs for the 200 Area waste sites is discussed in Sections 4.0 and 5.0 of DOE/RL-98-28. Further assessment of potential ARARs, which may include revisions to this earlier compilation, will be conducted for this OU during the FS.

The COC list presented in Table 3-4, which was developed during the second DQO process completed in the fall of 2004, is appropriate for use during the investigations that will be conducted in conjunction with the confirmatory and/or cleanup verification phases for pipelines and diversion box waste sites. Specific remedial action work plan (RAWP) SAPs will be prepared and tailored for specific waste site conditions and selected remedial responses following completion of the ROD.

4.1.5 Data Quantity

No additional sampling is needed to refine the contaminant distributions models for pipelines and diversion boxes. The remedial evaluation process for these waste sites can proceed using currently available information in conjunction with additional pertinent characterization data that will be available by other projects in the near future.

4.2 APPROACH FOR CONFIRMATION OF SITE PROFILES

It is estimated that hundreds of miles of process waste underground pipelines are present in Hanford's 200 Areas. Sixteen diversion boxes and 10 catch tanks have been identified outside the tank farm WMA. It would not be practical, nor economically feasible, to conduct site characterization studies at all of these structures prior to completing the RI report.

The site profiles that have been developed provide a basis for moving forward with an assessment of remedial alternatives for the pipeline, diversion boxes, and associated waste sites. Sufficient existing liquid contaminant release data are currently available from other Hanford waste sites and previous pipeline evaluations to provide an understanding of the probable range of conditions that will be encountered at these waste sites and to identify applicable remedial alternatives.

With the approach proposed for remedial decision making presented in this work plan, waste site characteristics of individual pipeline segments and diversion boxes will be confirmed after completion of the ROD. A focused field investigation will confirm the attributes at each waste site and support application of the selected remedy. This approach optimizes the use of the data collected and focuses on remedy decisions, resulting in a more cost-effective and efficient process. Confirmation of site characteristics will rely on a number of investigative techniques. A pipeline and diversion box investigation and evaluation plan, designed to confirm waste site attributes (e.g., integrity of connections, absence/presence of leakage to surrounding soil, presence/absence of residual fluids in the pipes, pipe location, pipe depth, etc.), will be prepared after issuance of the ROD. Investigation techniques and methodologies that may be used during these site confirmation evaluations are presented below. The SAPs to support different remediation approaches will be completed in conjunction with development of RAWPs following issuance of the ROD.

4.2.1 Analysis of Pipe Interiors

Current conditions within the interiors of buried pipelines will be assessed, as appropriate. Inspections of the interiors of pipelines will be performed if required for selecting between alternate remedial alternatives or if specific information regarding residual waste is needed for disposal decisions. Analyses may include both visual inspections and/or sampling activities. These evaluations will be conducted in conjunction with other testing used to confirm certain attributes such as the absence of breaks, breaches or cracks in the pipeline, presence/or absence of blockage along the line segment, and characteristics of residuals fluid and/or scale if it is present. This investigation will generally be conducted remotely and will be dependent on access availability and a hazard assessment. Analysis techniques may include camera surveys, radiological monitoring, and sampling and analysis.

4.2.1.1 Camera Surveys

Examination of the interior of pipelines will be performed using a camera at selected locations where access is available and exposure hazards are manageable. This investigative technique can provide real-time information on the current condition within buried pipelines. Camera surveys/inspections reveal if corrosion, debris, or waste residue is present. Areas where leakage may have occurred can be identified and generally would be visible as cracks, breaks, or gaps in pipe connections. The size and number of these breaches would be used in estimations of the potential magnitude and extent of releases. The inspections could also indicate those pipeline segments that are fully intact, open, and dry and show no signs of past failure or leakage.

4.2.1.2 Radiological Surveys

Radiological surveys of pipeline interiors can provide information concerning presence of absence or residual radiological contamination. A number of deployment systems are available, with some that include a configuration with camera survey equipment. Alpha, beta, and gamma radiation detectors can be used with some systems.

4.2.1.3 Sampling Pipe Scale

In some cases, residual build-up or scale may be present within the interiors of some pipelines. Sampling and analysis of this material may be required to determine what constituents are present in order to finalize remedial decisions and/or for disposal considerations.

4.2.2 Pipeline Locations

Several geophysical techniques are available and can be used as needed to confirm the locations and depths of pipelines. Following completion of the compilation of information concerning pipeline locations and depths (in particular, areas as determined from engineering drawings), selected geophysical surveys may need to be conducted prior to implementation of remedial activities.

4.2.2.1 Ground-Penetrating Radar and Electromagnetic Induction

Surface geophysical surveys using ground-penetrating radar (GPR) and electromagnetic induction (EMI) techniques will be used to verify the locations of pipelines as needed. GPR uses a transducer to transmit frequency module (FM) electromagnetic energy into the ground. Interfaces in the ground, defined by contrasts in dielectric constants, magnetic susceptibility, and, to some extent, electrical conductivity, reflect the transmitted energy. The GPR system measures the travel time between transmitted pulses and arrival of reflected energy. The reflected energy provides the means for mapping subsurface features of interest. The display and interpretation of GPR data are similar to those used for seismic reflection data. When numerous adjacent profiles are collected, often in two orthogonal directions, a plan view map showing the location and depth of underground features can be generated.

The EMI technique is a non-invasive method of detecting, locating, and/or mapping shallow subsurface features. It complements GPR because of its response to metallic subsurface anomalies and because it provides reconnaissance-level information over large areas to help focus GPR efforts. The EMI techniques are used to determine the electrical conductivity of the subsurface and are generally used for shallow investigations. The method is based on a transmitting coil radiating an electromagnetic field that induces eddy currents in the earth. A resulting secondary electromagnetic field is measured at a receiving coil as a voltage that is linearly related to the subsurface conductivity.

4.2.3 Evaluation of Soils Adjacent to Pipelines and Diversion Boxes

Confirmation of the presence or absence of contaminants in soils adjacent to pipelines, diversion boxes, and associated structures will be undertaken at each waste site, as needed. Investigations will use geophysical and/or soil sampling methods. Techniques that will be used are discussed in the following subsections.

4.2.3.1 Direct-Push Investigative Techniques

Direct-push subsurface investigative techniques will be employed as part of the leak assessment confirmatory analysis for selected pipeline waste sites. Cone penetrometer technology (CPT) will be used to provide rapid, cost-effective, real-time data and limit generation of investigation-derived waste (IDW). This technology can be used to collect information relating to a number of in situ soil characteristics including organic and inorganic compound concentrations, gamma radiological levels, soil moisture, and permeability. A particular advantage of this technology is that no sample collection is required because measurements are taken directly within the soil. Detector probes are pushed to the required depth of investigation using truck-mounted hydraulic force. This technology will work well in the unconsolidated sediments and fill material adjacent to buried pipelines.

The CPT equipment can also be configured to collect soil or liquid samples, if needed. Additional small-volume sample collection may also be conducted as needed using other direct-push applications such as GeoProbe™ or Enviro-Core® sampling devices.

4.2.3.1.1 Geophysical Logging Through Driven Soil Probes. Where radionuclide contaminants are suspected to be present in the soil, radioactivity levels may need to be assessed at a number of locations, both parallel and perpendicular to pipelines prior to implementing remedial actions. Based on process knowledge, radioactive contamination is expected to be represented by gamma emitters (e.g., cesium-137). Driven soil probes can be installed and logged with gamma-logging tools (gross gamma tool for GeoProbe or CPT and high-resolution spectra gamma-ray logging system). The depth of a driven soil probe is limited by the subsurface conditions (i.e., cobbles or gravel). The hole will be pushed as deep as possible, but a maximum depth of approximately 18 m (60 ft) bgs is anticipated for investigation planning. Gross gamma and passive neutron (GG/PN) logging of soil probes also may be used to determine areas of high americium-241 and plutonium-239/240 concentrations in a series of shallowly driven, small-diameter soil probes.

The GG/PN system uses bismuth-germanium detector instrumentation for gross counting of the gamma-emitting radionuclides in the soil probes as a function of depth. The passive neutron-logging instrument is a helium-3 detector configured to detect the neutron flux present in the below-ground soil probe environment.

GeoProbe™ is a trademark of GeoProbe Systems, Salinas, Kansas.
Enviro-Core® is a registered trademark of Precision Sampling, Inc., Richmond, California.

4.2.3.1.2 Soil Gas Surveys Through Driven Soil Probes. Determination of soil gas concentrations will be performed adjacent to pipelines or diversion boxes that are known to have handled process waste streams that included volatile organic compounds as a major constituent. Results of these analyses will support site profile attribute assumptions concerning releases from the structure.

4.2.3.2 Drilling and Sampling

For those pipeline and diversion box waste sites that require soil samples to confirm remedial decision making, boreholes will be installed to collect waste characterization data. The depth of drilling and associated soil sampling will be based on site-specific conditions. When available information indicates the presence of deep vadose zone contamination at a waste site, soil samples will be gathered to the water table. For waste sites where deep contamination has not been observed, sampling to groundwater will not be necessary. In this case, the drilling and sampling depths will be determined using the observational approach. As a minimum, samples will be collected to the deepest significant confining geological unit (e.g., the Cold Creek unit, if present), and as a maximum, to the water table.

4.2.3.3 Test Pit Excavation and Sampling

Pipeline segments or diversion box waste sites at some locations may require test pits to confirm remedial decisions. Depth of exploratory excavations and associated soil sampling will be based on site-specific conditions. The test pit locations may be chosen to target the accessible areas of interest, such as suspected leak locations below or adjacent to structures. The sample collection strategy will characterize the vadose zone materials directly beneath potential or suspected leak locations. Sampling generally will begin at the first sign of radiological contamination, as determined by field measurements. This contamination is expected to begin at the bottom of the waste site structure (i.e., pipeline or diversion box), but if contamination is detected in backfill materials above the waste site bottom, the backfill materials also will be sampled. Samples typically will be collected at smaller intervals near the potential release point (i.e., the bottom of a diversion box) and at larger intervals with increasing depth. Samples that were identified as critical during the DQO process will be collected at 4.6 m (15 ft) bgs and 7.6 m (25 ft) bgs. Additional samples may be collected at the discretion of the geologist or sampler based on field screening and geologic information (e.g., changes in lithology). If the disposal of mobility-enhancing chemicals creates a potential for significant contamination below the 7.6-m (25-ft) depth of a standard test pit, assessing the contamination at a depth greater than 7.6 m (25 ft) may be required.

4.2.3.4 Field Screening

Field screening radiological instrumentation will be used for initial assessment of radioactivity at release locations that are under investigation. Soil samples will be also be screened for nonradiological constituents using field instruments, test kits, or laboratory methods, as appropriate. Field screening techniques will be used principally in support of removal actions and used as real-time data to make excavation decisions.

4.2.3.5 Analysis of Soil

Samples will be collected at those locations where analyses of radiological and nonradiological COCs in the soil are needed and may include determination of select soil properties. The list of COCs (Table 3-4) was determined based on an evaluation of all potential contaminants that were transferred through the pipelines and diversion boxes. A limited number of samples will be analyzed to determine soil physical properties (e.g., moisture content and particle size).

Table 4-1. 200-IS-1 Waste Site Profiles for Pipelines and Diversion Boxes.

Site Profile Number	Waste Streams Handled by the Structure	Waste Stream Radiological Activity	Depth of Burial Below Ground Surface at Base of Structure	Leak Characteristics
1	Cooling water, steam condensate, and chemical sewer liquid waste	Low	0 to 15 ft	Suspected non-leaking
2				Known or suspected to have leaked
3			>15 ft	Suspected non-leaking
4				Known or suspected to have leaked
5	Process condensates, process wastes, tank wastes, scavenged wastes, laboratory wastes	Moderate	0 to 15 ft	Suspected non-leaking
6				Known or suspected to have leaked
7			>15 ft	Suspected non-leaking
8				Known or suspected to have leaked
9	Single-shell tank and double-shell tank wastes, transuranic-bearing streams	High	0 to 15 ft	Suspected non-leaking
10				Known or suspected to have leaked
11			>15 ft	Suspected non-leaking
12				Known or suspected to have leaked
13			Encased 0 to 15 ft	Suspected non-leaking
14				Known or suspected to have leaked
15			Encased >15 ft	Suspected non-leaking
16				Known or suspected to have leaked

5.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY PROCESS

This section describes the RI/FS (assessment) process for the 200-IS-1 OU pipelines, diversion boxes, and associated waste sites. The development of and rationale for this process are provided in DOE/RL-98-28 and are summarized in Figure 1-1. The process follows the CERCLA format, with modifications to concurrently satisfy the requirements specific to RCRA TSD units and RPP waste sites undergoing closure. Section 5.1 summarizes the integrated regulatory process for CERCLA and RCRA. Section 5.2 outlines the tasks to be completed during the RI phase, including planning and preparing the RI report, and the strategy to assess human health and ecological impacts. These tasks are designed to effectively manage the work, satisfy the DQOs identified in Section 3.0 and to document the results of investigations. For this work plan approach, the RI will present information concerning the predicted nature and extent of contamination within the confines of the waste site, potential activities of radionuclide contaminants (based on waste stream process knowledge), and potential transport of contaminants. The RI report will also provide data to determine the need for and type of remediation. Tasks to be completed following the RI include an FS with a RCRA TSD unit closure plan (Section 5.3) and a proposed plan and proposed RCRA Permit modification for RCRA TSD units that may include RPP waste sites, followed by a ROD and RCRA Permit modification for RCRA TSD units and RPP sites, as appropriate (Section 5.5).

Project management occurs throughout the RI/FS process. Project management is used to direct and document project activities so objectives of the work plan are met and the project remains within budget and on schedule. The initial project management activity will be to assign individuals according to roles established in Section 7.2 of DOE/RL-98-28. Other project management activities include day-to-day supervision of and communication with project staff and support personnel; meetings; control of cost, schedule, and work; records management; progress and final reports; quality assurance; health and safety; and community relations.

5.1 INTEGRATED REGULATORY PROCESS

An important part of the Tri-Party Agreement is the integration of RCRA and CERCLA activities whenever practicable. The 200-IS-1 OU contains both CERCLA waste sites and RCRA TSD units and components (e.g., 241-CX-70, 241-CX-71, and 241-CX-72 storage tanks; and the SST pipelines and diversion boxes). The final disposition of the TSD tank farm components (i.e., RCRA-regulated pipelines and diversion boxes) will have to meet both CERCLA remedial action and RCRA closure requirements.

RCRA and CERCLA will be integrated to address closure and environmental requirements for the pipeline and diversion box waste sites as effectively and efficiently as possible. Integrating RCRA and CERCLA allows additional options for removal and/or remedial actions, disposal, and closure. By allowing flexibility in final disposal options, DOE, Ecology, and EPA intend to minimize disposal costs as much as possible while remaining fully protective of human health and the environment.

An integration of CERCLA and RCRA regulatory requirements was used to develop this RI/FS work plan. The work plan presents the content needed for both a CERCLA RI/FS work plan and a RCRA RFI/CMS work plan. General facility background information and the current remedial alternative under consideration are presented. This work plan also provides RCRA TSD unit closure plan information such as facility description, location, and process information (Sections 2.1 and 2.2), waste characteristics (Section 3.0), and groundwater monitoring (Section 3.0). Following completion of the work plan, the RI will be conducted, which will satisfy the requirements for an RFI and will provide the data needed to support the selection of a closure strategy for RCRA TSD units, components, and ancillary equipment. The RI will include an evaluation of both 200-IS-1 OU waste sites regulated by CERCLA, and the TSD units, components, and ancillary features that are regulated by RCRA.

Concurrent with completion of the RI report, the remedial alternatives and closure strategies will be evaluated and compared against performance standards. The integration process for the evaluation of remedial alternatives includes preparing a CERCLA FS and proposed plan that will satisfy the requirements for a CMS report and a RCRA TSD unit closure plan. The recommended alternative, which generally is included in the CMS, is in the proposed plan under CERCLA. The FS also will include a section that provides corrective action recommendations for RPP sites. Additional discussion of the FS/closure plan workscope is provided in Section 5.3.

The RCRA closure options (i.e., landfill, modified, and clean closure, as defined in Condition II.K. of the Hanford Facility RCRA Permit) will be integrated with the CERCLA options and based on the alternative selected and the amount of cleanup that can be accomplished by the alternative. Landfill closure under RCRA will include the construction of an engineered barrier over the unit and equates to what is typically termed as a "containment alternative" under CERCLA. A modified closure option includes alternatives that leave contaminants in place above WAC 173-340-740, Method B cleanup standards in soil, debris, or groundwater. A clean closure option requires that all contaminated material and media be removed and decontaminated to levels below WAC 173-340-740, Method B.

The lead regulatory agency (Ecology) will prepare the CERCLA ROD following completion of the public involvement process for the proposed plan, which, after signature by the signatories to the Tri-Party Agreement, will authorize the selected remedial action. The closure decisions for the RCRA TSD units that were contained in the CERCLA proposed plan and ROD will be administratively documented in the Hanford Facility RCRA Permit. A letter will be issued declaring that the closure of the RCRA TSD units/components is finished once the selected remedies have been implemented and a closure certification has been prepared. The modification of the Hanford Facility RCRA Permit will consist of adding a section that will include an explanation stating that the required closure information is included in the CERCLA documentation. Additional discussion concerning the proposed plan/proposed RCRA Permit modification is provided in Section 5.4, with Section 5.5 providing additional detail relating to post-ROD and/or permit modifications and post-closure activities.

For the implementation phase, the remedial design report (RDR)/RAWP will contain the required information concerning confirmation sampling and design of the remedies for the CERCLA waste sites and the RCRA TSD units/components. Finally, the operations and maintenance (O&M) plan will contain the information, if needed, for surveillance, inspections, monitoring, etc., for the remedies implemented for the CERCLA waste sites and RCRA TSD units/components. If post-closure requirements are needed for the RCRA TSD components, then a section will be added to the Hanford Facility RCRA Permit to include a statement that post-closure information is included in the CERCLA documentation.

During the CERCLA remedial action process, there may be an opportunity to implement a remedy for a certain category of waste sites by performing a removal action separate from the remedial action for 200-IS-1/200-ST-1. This removal action will be documented in an engineering evaluation/cost analysis (EE/CA) and either attached to one of the remedial action documents or issued separately. The categories of waste sites that may be considered for a separate removal action may include TSD units/components. A closure plan will be prepared and attached to the EE/CA that will describe how the implementation of the remedy will satisfy RCRA closure requirements. Similar steps would be conducted, as previously described, to administratively include closure information in the Hanford Facility RCRA Permit. The Hanford Facility RCRA Permit information would indicate that the closure information is contained in the EE/CA.

This integration process fully addresses each technical and procedural element of RCRA and CERCLA so redundant work is not required at the waste sites. The CERCLA public involvement process, including public notice and opportunity to comment, will be enhanced as necessary to concurrently satisfy the public involvement requirements for the RCRA closure and RPP processes. The public will be given an opportunity to review and comment on the proposed permit conditions that will be contained in the proposed plan. The proposed plan, with a draft permit modification, will be issued for a minimum 45-day public review and comment period. Supporting documents, including the FS and closure plan, will be made available to the public for review at the same time. A combined public meeting/public hearing may be held during the comment period to provide information on the proposed action and permit modification and to solicit public comment.

The document sections from a RCRA closure plan that have been integrated into the CERCLA documentations are outlined below:

- 200-IS-1/200-ST-1 RI/FS work plan, containing TSD unit/component(s) information applicable to closure plan sections:
  - Section 2.0, "Facility Description and Location Information"
  - Section 3.0, "Process Information"
  - Section 4.0, "Waste Characterization"
  - Section 5.0, "Groundwater Monitoring."
- 200-IS-1/200-ST-1 RI report, which contains the following TSD unit/component(s) closure information:
  - TSD unit characterization data.
- 200-IS-1/200-ST-1 FS, containing TSD unit/component(s) information applicable to closure plan sections:
  - Section 6.0, "Closure Strategy and Performance Standards"
  - Section 7.0, "Closure Activities"
  - Section 8.0, "Post-Closure Plan."
- 200-IS-1/200-ST-1 proposed plan:
  - Discusses TSD units/components and proposed closure actions
  - Contains crosswalk showing where TSD unit closure information can be found in CERCLA documents (e.g., RI/FS work plan, RI report, and FS).

- Hanford Facility RCRA Permit modification:
  - Add section for TSD unit(s)/components(s)
  - TSD units/components section contains explanation that closure information is contained in the CERCLA documents
  - CERCLA documents will not be attached or appended to the permit
  - TSD units/components section contains explanation that post-closure information is contained in the CERCLA documents (e.g., RDR/RAWP and O&M plan).
- 200-IS-1/200-ST-1 RDR/RAWP, which describes final remedies selected for TSD units/components:
  - Includes a SAP for confirmation/verification sampling for both waste sites and TSD units/components.
- 200-IS-1/200-ST-1 O&M plan:
  - Details post-remediation and closure operations, inspection, and/or monitoring activities, as needed.

5.2 REMEDIAL INVESTIGATION ACTIVITIES

The following subsections summarize the planned tasks that will be performed during the RI phase for the pipelines,diversion boxes, and associated waste sites within the 200-IS-1 OU:

- Planning
- Compilation and detailed review of existing characterization data
- Assessment of need for treatability studies
- Data evaluation and preparation of RI report.

These tasks and subtasks reflect the work structure that will be used to manage the work and develop the project schedule provided in Section 6.0.

5.2.1 Planning

The planning subtask includes tracking and coordinating activities to be completed and documentation that will be acquired for use in the RI. For the pipeline and diversion box waste sites, this would include interfacing with other organizations and/or project managers who will be providing information for presentation in the 200-IS-1 RI report. Coordinating and integrating schedules and plans with those operations or organizations that will be providing certain data elements will need to be performed. Prioritization of data acquisition activities will be needed to optimize the benefits of available characterization information, conceptual site knowledge, and remedial strategies as they develop.

5.2.2 Compilation and Detailed Review of Existing Characterization Data

As discussed in Section 4.0 and presented in Appendix G, a large amount of existing site characterization and/or waste attribute data applicable to preparation of the RI report and supporting remedial decision making for the 200-IS-1 OU are currently available or will be available. Compilation and use of this data to further support the site profile development, contaminant nature and extent evaluation, and risk assessment analysis will be completed as part of the RI report. Much of the assembled data will also be used in support of the remedial alternatives analysis conducted in the FS. As available, additional site attribute data that will be gathered and used in the RI and FS evaluations includes the following:

- Construction materials
- Pipeline diameter
- Depth of burial
- Waste transfer records (from point of origin to storage or disposal locations)
- Waste stream characteristics
- Documentation of releases
- Age of pipelines, diversion boxes, and related structures
- Dates that pipelines, diversion boxes, and related structures were taken out of service
- How the pipeline or diversion box was taken out of service (flushed and/or plugged lines)
- Why the structure was taken out of service
- Integrity testing results (hydrostatic or die leak tests).

5.2.3 Assessment of Need for Treatability Studies

In conjunction with the RI data compilation and assessment, the FS activities will be initiated and will include the use of site profiles attributes in the identification of applicable remedial alternatives. The need to conduct treatability studies will be evaluated early in the RI. Treatability studies may be required to verify the feasibility of a technology, cost of a remedy, or applicability of a technology or action under different site conditions. If possible, costs for implementation of the remedies being considered will be obtained from completed projects in other parts of the Hanford Site (i.e., 100 or 300 Areas) or at other DOE facilities.

5.2.4 Data Evaluation and Reporting

Data will be compiled from other project sources for use in the 200-IS-1 OU RI. A large amount of supporting information will be gathered and presented in the RI. Any analytical data used will be qualified, as appropriate, based on validation documentation. Historical engineering drawings and facility operations documents will be cited in support of site profile attribute descriptions.

5.2.5 Remedial Investigation Report

The following subsections summarize additional subtasks included in preparation of an RI report. The primary activities include data compilation; evaluating the nature, extent, and concentration of contaminants based on sampling results; assessing contaminant fate and transport; refining the site conceptual models; and evaluating risks through a risk assessment. These activities will be performed as part of the RI report preparation task.

5.2.5.1 Risk Assessment Framework

The Tri-Parties undertook the task of developing a risk framework to support risk assessments in the Central Plateau. This included a series of workshops with representatives from DOE, EPA, Ecology, the Hanford Advisory Board (HAB), the Tribal Nations, the State of Oregon, and other interested stakeholders. The workshops focused on the different programs involved in activities in the Central Plateau and the need for a consistent application of risk assessment assumptions and goals. The results of the risk framework are documented in HAB Advice #132, in the Tri-Parties' response to the HAB advice (02-HAB-006), and in the *Report of the Exposure Scenarios Task Force* (HAB 2002). The following items summarize the risk framework description from the Tri-Parties' response to the HAB:

1. The core zone (200 Areas, including B Pond [main pond] and S Ponds) will have an industrial land-use scenario for the foreseeable future.
2. The core zone will be remediated and closed allowing for "other uses" consistent with an industrial scenario (environmental industries) that will maintain active human presence in this area, which in turn will enhance the ability to maintain the institutional knowledge of waste left in place for future generations. Exposure scenarios used for this zone should include a reasonable maximum exposure to a worker/day user, to possible Native American users, and to intruders.
3. DOE will follow the required regulatory processes for groundwater remediation (including public participation) to establish the points of compliance and remedial action objectives. It is anticipated that groundwater contamination under the core zone will preclude beneficial use for the foreseeable future, which is at least the period of waste management and institutional controls (150 years). It is assumed that the tritium and iodine-129 plumes beyond the core zone boundary will exceed the drinking water standards for the period of the next 150 to 300 years (less for the tritium plume). It is expected that other groundwater contaminants will remain below, or be restored to, drinking water levels outside the core zone.
4. No drilling for water use or otherwise will be allowed in the core zone. An intruder scenario will be calculated for in assessing the risk to human health and environment.
5. Waste sites located outside of the core zone but within the Central Plateau (e.g., 200 North Area, Gable Mountain Pond, and B/C Crib controlled area) will be remediated and closed based on an evaluation of multiple land-use scenarios to optimize land use, institutional control cost, and long-term stewardship.
6. An industrial land-use scenario will set cleanup levels on the Central Plateau. Other scenarios (e.g., residential or recreational) may be used for comparison purposes to support decision making, especially for the following:
   - Post-institutional controls period (greater than 150 years)
   - Sites near the core zone perimeter to analyze opportunities to "shrink the site"
   - Early (precedent-setting) closure/remediation decisions.
7. This framework does not deal with the tank retrieval decision.
   - These items form the basis for the OU risk assessments to be conducted in the RI/FS reports.

5.2.5.2 Human Health Risk Assessment

For the 200-IS-1 OU, a quantitative, baseline human health risk assessment will be prepared as part of the RI report. It is important to note that to support the baseline risk assessment, completed risk assessments conducted for process facilities, tank farms, and other applicable waste sites will also be evaluated and included in 200-IS-1 OU analyses. Results of these other risk assessments will be integrated and used to support an evaluation of the risk posed by residual waste associated with pipelines, diversion boxes, and associated waste sites . Initially, the risk assessments presented in the following reports will be reviewed:

- RPP-13774, *Single-Shell Tank System Closure Plan (WMA C Risk Assessment)*
- RPP-21596, *Risk Assessment for Waste Management Area S-SX Closure Plan*
- DOE/RL-2003-64, *200-TW-1&2 Operable Units and 200-PW-5 Operable Unit Feasibility Study*
- DOE/RL-2004-24, *200-CW-5, 2,4, and 200-SC-1 Operable Units Feasibility Study*
- DOE/RL-2002-69, *200-CW-1 OU and 200-CW-3 Operable Unit Feasibility Study.*

The baseline risk assessment will evaluate risk to human receptors from potential exposure to contaminants in accessible surface sediments and shallow subsurface soils. The risk assessment will also evaluate the potential for contaminants currently in the vadose zone beneath the waste sites to impact groundwater in the future. Risks from current groundwater contamination will not be evaluated; this evaluation will be conducted as part of the RI/FS process for the groundwater OUs.

The risk assessment presented in the RI report will use available data compiled for pipeline and diversion box waste sites and will be sufficient to allow quantification of risk. The risk assessment will follow the risk guidelines identified through the risk framework workshops as documented in the Tri-Parties' response to HAB Advice #132 (02-HAB-006).

The human health risk assessment will be conducted in accordance with appropriate subsections of WAC 173-340, "Model Toxics Control Act – Cleanup," and with the following DOE and EPA guidance documents:

- DOE/RL-91-45, Rev. 3, *Hanford Site Risk Assessment Methodology*
- EPA 540/1-89/002, *Risk Assessment Guidance for Superfund (RAGs), Volume I – Human Health Evaluation Manual, Part A* (Interim Final)
- OSWER Directive 9285.6-03, *Risk Assessment Guidance for Superfund, Vol. I, Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors* (Interim Final)
- EPA 600/P-95/002Fa, *Exposure Factors Handbook*
- EPA 540/R-99/005, *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (Interim)
- EPA 600/P-92/003C, *Proposed Guidelines for Carcinogen Risk Assessment*
- OSWER Directive 9285.7-081, *Supplemental Guidance to RAGs: Calculating the Concentration Term.*

Risks will initially be evaluated by comparison to risk-based standards such as WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties." Contaminants present at concentrations exceeding these risk-based standards will be considered further in the risk assessment process. Risks from nonradiological noncarcinogens will be evaluated by calculating hazard quotients for individual constituents and a hazard index for cumulative risk. Risks from nonradiological carcinogens and radionuclides will be evaluated by calculating incremental cancer risks for individual constituents and a cumulative cancer risk.

The RESidual RADioactivity (RESRAD) computer program (ANL/EAD-4), will be used to obtain risk and dose estimates from direct-contact exposure to radiological constituents present in the shallow zone of the waste sites. The RESRAD model will also be used to obtain risk and dose estimates for the protection of the groundwater pathway. The results obtained from the RESRAD model for groundwater protection are limited to screening purposes only. Additional analysis will be performed using an appropriate fate and transport model (e.g., PNNL-11216, *STOMP – Subsurface Transport Over Multiple Phases: Application Guide*) to assess impact to the groundwater from chemicals and radionuclides in the vadose zone.

Because waste sites within the 200-IS-1 OU all are located inside the Core Zone, risk assessment will be performed for an industrial exposure scenario to establish the baseline risk. As part of the FS, additional risk assessment may be performed to evaluate other scenarios, such as a Native American scenario or an intruder scenario, to evaluate post-remediation residual risks.

Waste sites will be evaluated in the FS based on site profile attributes. Confirmation of contaminant concentrations, distribution, and pathway availability will be completed at each site during the confirmatory and design sampling processes after issuance of the ROD. Qualitative risk determinations will be prepared where no existing data for the site profile are available. Site attribute and hydrogeologic information used in risk calculations include the following:

- Waste site configuration and construction (multiple pipelines within a sealed encasement or direct-buried single pipelines)
- Depth of burial (above or below the 15-ft direct human exposure point of compliance)
- Known or estimated volume of waste streams released in relation to the available pore volume of soil underlying the waste site
- Types and amounts of contaminants transferred by the pipeline and associated stucture; contaminant inventory
- Release mechanism (minor isolated cracks or breaks or major discontinuities and breaks throughout the line)
- Expected distribution of contamination based on configuration of the waste site
- Geological setting
- Neighboring waste sites, structures, or utilities
- Potential for hydrologic and contaminant impacts to groundwater.

Information associated with each waste site profile will be evaluated in the FS. In cases where characterization data are available for a waste site with attributes matching the site profile, the data will be evaluated for sufficiency and then used to support an evaluation of risk. If the data are sufficient, a risk estimate for the site will be calculated and then used to support the evaluation and selection of the appropriate remedial action for those waste sites with attributes matching the site profile. Existing information from the WIDS database, discharge information, and general process information will be used to make qualitative assessments of risk.

The existing characterization data that will be compiled from other sources for pipeline and diversion box waste sites should provide sufficient information to select remedies for waste sites comprising each site profile. However, site-specific data may also be needed to verify that the selected remedial alternative is appropriate. Following the decision in the ROD, sampling will be conducted to confirm the selected remedy for each waste site and to collect data to support remedial design. Following remedial action, additional data collection will be performed as needed to verify achievement of cleanup goals.

A risk evaluation will be conducted for each waste site using confirmatory and/or verification sampling results. Using PRG values for COCs should provide a sufficient indication of level or risk posed at the site. A quantitative risk assessment would only be necessary if a leave-in-place remedial alternative is being considered. For sites that are candidates for a removal action, final verification sampling results will provide sufficient data to document that cleanup standards specified in the ROD have been achieved.

5.2.5.3 Ecological Evaluation and Risk Assessment

The screening-level ecological risk assessment in DOE/RL-2001-54 is meant to be a conservative evaluation of risk to ecological receptors from stressors, in this case, introduction of contaminants and habitat elimination. The screening-level ecological risk assessment identifies pathways for ecological receptors to be exposed to the contamination and evaluates potential risk from those exposures. The following describes the information found in specific sections of DOE/RL-2001-54.

Section 2.0 of DOE/RL-2001-54 describes the physical and ecological setting of the Central Plateau and identifies important aspects of the ecology and the condition of the waste sites to consider during the ecological risk assessment. For instance, while most waste sites are in a disturbed habitat with little vegetation to support wildlife, the nearby shrub-steppe offers a more habitable location for wildlife and needs protection in this region due to encroachment and elimination of this habitat in other parts of eastern Washington. Individual species whose populations are limited and are designated as sensitive species must also be protected. Recent surveys of the biological diversity on the Hanford Site have identified a number of new-to-science species and the protection status of these species has not yet been determined. More information is needed to help with this determination. Regarding the waste sites, most of the waste in the waste sites has been stabilized, thereby limiting ecological access. The decisions to stabilize and remediate waste sites must balance the potential disruption to the ecosystem both at and adjacent to the waste sites as well as from a distant location (e.g. borrow source sites).

The conceptual site model presented in Section 3.0 of DOE/RL-2001-54 provides an understanding of the ecological resources and the ways that receptors may be exposed. The model shows where chemicals and radionuclides from the waste sites are likely to come into contact with receptors in the environment. The exposure pathways that are expected to be complete at most waste sites include the following:

- Direct contact with, or ingestion of, soil by invertebrates (e.g., beetles and ants) and burrowing mammals
- Uptake of contaminants in soil by vegetation
- Bioaccumulation through ingestion of food items (e.g., food-chain effects) consumed by wildlife that may forage at the waste sites.

Section 4.0 of DOE/RL-2001-54 discusses the toxicity values that are available for contaminants believed to be present in the Central Plateau. Contaminants were identified from preliminary sampling data available from a subset of waste sites. These contaminants were then screened, primarily with respect to the likelihood to be present in the environment (i.e., half-life and persistence). A literature search for bird and mammalian toxicity values was performed. Toxicity values are not available for some contaminants. A risk management decision will be needed to determine how contaminants that do not have toxicity values will be handled during the risk assessment for each OU.

Section 5.0 of DOE/RL-2001-54 presents the exposure parameters used for estimating the exposure in a quantitative manner. In a screening-level ecological risk assessment, most exposure parameters are set conservatively at 100%. The only organism-specific factor necessary will be body weight, and this data are available in the literature. This section further evaluated the exposure pathways and constructed a food-chain exposure model for wildlife specific to the Central Plateau. The wildlife is shown in the food chain and habitat model in DOE/RL-2001-54.

DOE/RL-2001-54, Section 6.0, is the screening-level risk calculation for the Central Plateau. The state and DOE provide contaminant-specific numerical values (WAC 173-340-900 and below concentration guidelines [BCGs]) to potential risks. These are conservative numbers designed to address all possibilities without leaving potential risks out of consideration. Data are available for a subset of the Central Plateau waste sites. These maximum concentrations of contaminants detected at the waste sites were compared with the state and DOE screening-level values. For chemicals, 12 metals, pentachlorophenol, and 4-dinitrophenol were detected at a maximum concentration above the screening level. The high number of metals presenting a risk requires closer examination. Site-specific bioavailability data would be helpful for understanding whether this is a reflection of the conservative nature of the screening assessment or an actual risk to the ecosystems at the waste sites. For radionuclides, cesium-137, radium-226, radium-228, and strontium-90 were above acceptable limits in the soil samples. It is important to recognize the limitations and uncertainty associated with risks identified by screening-level assessments. The risk calculations are useful for determining relative risks between waste sites, not site-specific risk. The information should be considered carefully along with actual biological evidence from the waste site area to determine if a hazard exists. There are data available for hundreds of wastes sites in the Central Plateau (see Appendix C of DOE/RL-2001-54). These data include soil from the waste site, vegetation, and soil invertebrates. As each OU quantifies their risk using the exposure models available, these data will be useful in verifying the mathematical estimates.

The screening-level ecological risk assessment in DOE/RL-2001-54 leads to the problem-formulation stage of a baseline ecological risk assessment. During problem formulation, the risk managers and others consider the toxicity evaluation, conceptual model exposure pathways, and assessment endpoints to support cleanup decisions. As a result, they are then able to better define the initial risks and determine direction for the DQO process, if needed. The DQO process will include the following activities:

- Establish the level of effort needed to assess ecological risk at a particular site or OU
- Identify relevant and available data

- Design a conceptual model of the ecological threats at a site and measures to assess those threats
- Select methods and models to be used in the various components of the risk assessment
- Develop assumptions to fill data gaps for toxicity and exposure assessments based on logic and scientific principles
- Interpret the ecological significance of observed or predicted effects.

Ecological risk will be evaluated using the EPA eight-step process, as outlined in DOE/RL-2001-54, which serves as the screening-level assessment for the Central Plateau. For the 200-IS-1 and 200-ST-1 OUs, DOE/RL-2001-54 provides the starting point for OU-specific ecological evaluations that will include a screening-level evaluation based on the data collected during the RI and other existing data as available, which will be compared to screening-level concentrations protective of wildlife. Because the waste sites in these OUs are all within the core zone, only terrestrial wildlife risks will be evaluated. Consistent with this approach, WAC 173-340-7490(3)(b) specifies that for industrial or commercial properties, current or potential for exposure to soil contamination need only be evaluated for terrestrial wildlife protection. Plants and biota need not be considered unless the species is protected under the Federal *Endangered Species Act of 1973*. Currently, no federally listed threatened or endangered species are known to exist at the waste sites. Surveys prior to field activities will confirm the presence of protected species.

For radionuclides, screening levels have been developed in DOE/STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*. The international community has been involved for more than 20 years in evaluating the effects of ionizing radiation on plants and animals. The International Atomic Energy Agency (IAEA) issued a study in 1992, IAEA-TECDOC-332, *Effects of Ionizing Radiation on Plants and Animals at Levels Implied by Current Radiation Protection Standards*, endorsing the 1977 International Commission on Radiological Protection's (ICRP's) reports on *Recommendations of the International Commission on Radiological Protection* (ICRP Publication No. 26, ICRP Publication No. 60) and stating that chronic radiation dose rates below 0.1 rad/day will not harm plant and animal populations and that radiation standards for human protection will also protect populations of nonhuman biota. The report implies that dose limits of 0.1 rad/day for animals and 1 rad/day for plants will protect populations, but additional evaluation of effects may be needed if sensitive species are present.

Effects of Ionizing Radiation on Terrestrial Plants and Animals: A Workshop Report (ORNL/TM-13141) presents information from a DOE-sponsored workshop held in 1995. The workshop was attended by 12 experts in radioecology and ecological risk assessment. The goal of the workshop was to evaluate the adequacy of current approaches to radiological protection, as exemplified by the IAEA report. The attendees reviewed DOE's perspective and responsibilities, rationales underlying the IAEA conclusions, and a summary of ecological data from the former Soviet Union. The consensus of the workshop participants was that the 0.1 rad/day limit for animals and the 1 rad/day limit for plants recommended by the IAEA are adequately supported by the available scientific information. However, they concluded that guidance on implementing the limits is needed and that the existing data support application of the recommended limits for populations of terrestrial and aquatic organisms to representative rather than maximally exposed individuals.

In response to the workshop findings, DOE published DOE/STD-1153-2002, which provides a graded approach to ecological risk assessment for radionuclides and screening-level BCGs. For radiological constituents, no promulgated screening or cleanup levels are available. The BCGs from DOE/STD-1153-2002 will be considered in the ecological evaluation of radiological constituents.

DOE/RL-2001-54 is foundational to the Central Plateau ecological evaluation DQO process to be conducted in FY03. This DQO process will further develop data gaps identified in DOE/RL-2001-54 and identify data needs for the Central Plateau to support remedial decision making. An ecological evaluation SAP will be prepared and implemented for the Central Plateau, either on an area-wide basis or by OU, depending on the actual data needs.

Based on the results of the DQO and the screening-level evaluation, additional risk assessment activities, including a baseline ecological risk assessment, may be conducted using the eight-step process. The evaluation will be conducted based on soil data collected during the RI, existing soil and ecological data, and if identified during the Central Plateau ecological evaluation DQO, newly collected ecological data.

As the 200-IS-1 OU waste sites are located in both the 200 East and 200 West Areas (i.e., in close proximity of other OU waste sites), it is likely that data collected from neighboring sites will be applicable, including the ecological risk evaluation conducted during the 200-UP-2 OU LFI (DOE/RL-95-13) for the 200-W-42 or 216-U-8 VCP. The objective of the ecological risk evaluation was to assess potential risk to ecological receptors by (1) estimating potential risks to the Great Basin pocket mouse from exposure to waste site contaminants through the use of exposure models, and (2) evaluating biological monitoring data collected in the 200 UP-2 OU area. Uptake of contaminants from soil by vegetation was considered the primary source of contaminant entry to the food chain. Contaminants of potential ecological concern were identified for zones from 0 to 2 m (0 to 6 ft) and from 2 to 4.6 m (6 to 15 ft). Exposure pathways included ingestion of contaminated plant material, inhalation, and direct exposure to radioactive contaminants.

The evaluation was conducted based on biological monitoring data (WHC-MR-0418) and modeling results using relative risks to evaluate the sites. Plants collected from the 216-U-8 Crib during the 200-UP-2 OU LFI were analyzed for both radionuclides and metals. Modeling concentrations of metals as measured in plants inside a mouse resulted in an environmental hazard quotient (EHQ) >1 for aluminum (EHQ = 5,030), antimony (EHQ = 52.3), barium (EHQ = 7.66), copper (EHQ = 18.7), manganese (EHQ = 21.7), and vanadium (EHQ = 5.96). Estimating the radiation dose to the mouse following ingestion of plant matter revealed that exposure to the maximum activity concentration in plants from the site resulted in a total dose rate of 1.57 rad/day. Strontium-90 alone contributed approximately 99% of the total dose rate. Exposure of the mouse to radionuclides in the soil resulted in an estimated total dose at the 0 to 2.0-m (0 to 6-ft) interval and at the greater than 2- to 4.5-m (6- to 15-ft) interval to be less than 1 rad/day. Modeling results indicated that no chemicals of potential ecological concern were detected in soils from this site as having an EHQ >1. The ecological risk associated with the 216-U-8 Crib and the 216-U-8 VCP was considered medium to high.

5.2.5.4 Data Evaluation and Contaminant Distribution Conceptual Model Refinement

This task will consist of evaluating the information that has been compiled. The nonradiological and radiological data obtained from subsurface samples will be compiled, tabulated, and statistically evaluated to gain as much information as possible to satisfy data needs. Data evaluation tasks may include the following:

- Graphically evaluating the vertical distribution of contamination based on data gathered from driven soil probes, boreholes, or test pits.
- Stratifying the data and computing basic statistical parameters such as mean and standard deviation for individual levels when sufficient data are available. This evaluation can provide an indication of contaminant distribution.
- Constructing contour diagrams and variograms to evaluate spatial correlations within each stratum. This evaluation will indicate whether or not contamination is concentrated in a particular area (e.g., near the influent end for trenches).
- Performing statistical tests on the data to evaluate the presence or absence of contamination. This step has many facets, including determining the distribution of the data and selecting the appropriate statistical tests. The initial screening for contamination should evaluate the data with respect to background, by using simple comparisons of an upper bound of the data to background concentrations (e.g., *Model Toxics Control Act* tests), or through more complex comparisons, such as nonparametric hypothesis tests (e.g., Wilcoxon rank sum test). These tests also can be used to compare the data to appropriate cleanup levels.

These statistical evaluations will aid in refining the contaminant distribution conceptual models for this OU and selecting the remedial alternative. However, because the sites within the 200-IS-1 OU represent both single and multiple point-source types of releases, statistical analysis might not always be possible. If available data are not sufficient for statistical analysis, maximum or average concentrations will be used in the data evaluation process.

Data on the soil physical properties will be used to determine the soil type, which will assist in choosing the proper unsaturated hydraulic conductivity-moisture retention curve. Identifying the soil type and soil moisture will allow the determination of unsaturated hydraulic conductivity, which will be used as needed in modeling flow and transport (see Section 5.3.5.3).

The combined chemical, physical, and geophysical will be used for correlating subsurface data, for refining the preliminary conceptual contaminant distribution models, and as inputs to a qualitative risk assessment.

5.3 FEASIBILITY STUDY/CLOSURE PLAN

In conjunction with completion of the RI, remediation alternatives and closure strategies will be identified in this work plan will be more fully assessed and more fully developed. Alternatives will be evaluated against performance standards and selection criteria in the FS and appended RCRA TSD unit closure plans. The FS process consists of the following steps:

1. Defining RAOs and RCRA closure and RCRA corrective action performance standards.
2. Identifying general response actions to satisfy RAOs.

3. Identifying potential technologies and process options associated with each general response action.
4. Screening process options to select a representative process for each type of technology based on its effectiveness, implementability, and cost.
5. Assembling viable technologies or process options into alternatives representing a range of treatment and containment plus a no action alternative.
6. Evaluating alternatives and presenting information needed to support remedy selection and RCRA closure of the unit as a landfill or under modified or clean closure pursuant to Hanford Facility RCRA Permit, Condition II.K (WA 7890008967, *Hanford Facility RCRA Permit*).

Remedial action alternatives that have currently been identified as to applying to the 200-IS-1 pipelines, diversion boxes and associated waste sites are as follows:

- No action alternative (no institutional controls)
- Engineered multi-media barrier
- Excavation and disposal of waste
- Excavation with treatment and disposal
- In situ treatment (stabilization)
- Maintain existing soil cover/institutional controls/monitored natural attenuation.

Additional discussion concerning each of these potential alternatives as they would apply to the 200-IS-1 waste sites (particularly pipelines) is provided in Appendix I. With the strategy proposed in this work plan, as part of the FS, site profiles and the associated waste sites would be matched to preferred and alternate remedial responses. Two principal categories of remedial responses are currently identified, those actions that require removal and those that are leave-in-place responses. Leave-in-place remedies would include in situ treatment (stabilization), placement of an engineered barrier system over the site, or maintaining an existing soil cover if already present with institutional controls.

5.3.1 Matching Site Profiles to Remedial Responses

This work plan was developed assuming that a streamlined remedial alternative selection process can be used for the 200-IS-1 OU waste sites. With this approach, the site profiles and included waste sites that have been identified are matched or associated with an appropriate remedial response (Figure 5-1). Matching waste site profiles to a preferred remedial response(s) will be completed during the FS. Data that will be compiled and presented in the RI report will further support the site profile information that is currently presented in this work plan. Remedial alternatives will also be further investigated and requirements for additional data collection identified (i.e., need for a treatability study).

During the detailed analysis, each alternative will be evaluated against the following CERCLA criteria (40 CFR 300.430):

- Overall protection of human health and the environment
- Compliance with ARARs

- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume through treatment
- Short-term effectiveness
- Implementability
- Cost
- State acceptance.

One additional modifying criterion, community acceptance, will be applied following the FS at the proposed plan and ROD phase.

The NEPA values also will be evaluated as part of DOE's responsibility under this authority. These NEPA values include impacts to natural, cultural, and historical resources; socioeconomic aspects; and irreversible and irretrievable commitments of resources.

The RCRA closure performance standards (WAC 173-303-610[2]) will be used to evaluate the ability of alternatives to comply with RCRA closure requirements. These standards require the closure of TSD units in a manner that achieves the following:

- Minimizes the need for further maintenance.
- Controls, minimizes, or eliminates, to the extent necessary to protect human health and the environment, post-closure escape of dangerous waste, dangerous waste constituents, leachate, contaminated run-off, or dangerous waste decomposition products to the ground, surface water, groundwater, or the atmosphere.
- Returns the land to the appearance and use of surrounding land areas to the degree possible, given the nature of the previous dangerous waste activity.

In addition, RCRA corrective action performance standards (WAC 173-303-646[2]) will be used to evaluate how well the alternatives comply with RCRA corrective action requirements. These standards state that corrective action must achieve the following:

- Protect human health and the environment for all releases of dangerous waste and dangerous constituents, including releases from all solid waste management units at the facility.
- Occur regardless of the time at which waste was managed at the facility or placed in such units, and regardless of whether such facilities or unit were intended for the management of solid or dangerous waste.
- Be implemented by the owner/operator beyond the facility boundary where necessary to protect human health and the environment.

The FS also will include supporting information needed to complete the detailed analysis and meet regulatory integration needs, including the following:

- Summarize the RI, including the nature and extent of contamination, the contaminant distribution models, and an assessment of the risks to help establish the need for remediation and to estimate the volume of contaminated media.
- Refine the conceptual exposure pathway model to identify pathways that might need to be addressed by remedial action.
- Provide a detailed evaluation of potential ARARs, beginning with potential ARARs identified in the Implementation Plan (DOE/RL-98-28, Section 4.0).

- Refine potential RAOs and PRGs identified in the Implementation Plan (DOE/RL-98-28, Section 5.0) based on the results of the RI, ARAR evaluation, and current land-use considerations.
- Refine the list of remedial alternatives, identified in the Implementation Plan (DOE/RL-98-28, Appendix D) and in this section, based on the RI.
- Provide corrective action recommendations for RPPs to fulfill the requirements for a CMS report.
- Include as appendices closure plans to address RCRA TSD units in the OU. The closure plans will incorporate, by reference, specific sections of the work plan or RI report containing specific closure plan information. The closure plans will include closure performance standards, a closure strategy, general closure activities including verification sampling, and a general post-closure plan.

Additional RCRA integration guidance for preparing an FS/closure plan is provided in DOE/RL-98-28, Section 2.4.

5.4 PROPOSED PLAN AND PROPOSED RCRA PERMIT MODIFICATION

The decision-making process for the 200-IS-1 OU will be based on the use of a proposed plan, ROD, and modification to the Hanford Facility RCRA Permit. The proposed plan also will include a draft permit modification with unit-specific permit conditions for RPPs and the RCRA TSD units and components for incorporation into the Hanford Facility RCRA Permit.

During the RI/FS process, a number of options for development of proposed plans and RODs will be evaluated. Development of a ROD that supports elements of the "plug-in" approach and use of a contingent or alternate remedy will be evaluated. Design of the ROD will be consistent with use of a process where waste site profiles are confirmed prior to implementing a remedial response.

Since remedial actions may proceed on an OU-by-OU basis, alternative site groupings will be considered for waste sites in the Central Plateau. Several alternatives are currently under consideration, some of which may be used for the waste sites addressed in this work plan. Three alternatives to using the OU-by-OU remediation approach have been identified to provide flexibility in the decision-making process, facilitate early action, and remediate and close specific areas or zones. Examples of these alternatives are presented below.

5.4.1 High-Risk Waste Sites Identified for Early Action

This alternative accelerates the start of remedial actions and closure of waste sites that present an ongoing or expected future threat to groundwater. Some Central Plateau high-risk sites have already been identified for early actions near U Plant, PUREX, and PFP. These sites will be included in proposed plans and RODs that promote early action.

5.4.2 Regional Site Closure

Waste site remedial decision-making may be adjusted under a regional closure strategy that aligns wastes sites into groups defined by geographical zones. Under this strategy, waste sites in a geographical area may be remediated as a group, even though they may be in different OUs. A strategy to implement this regional closure strategy is being developed.

5.4.3 Waste Site Grouping by Characteristics or Hazards

A third example of remedial decision-making strategies would be based on a specific characteristic or hazard that mandate additional requirements, such as supplemental ARARs or more robust remedial alternatives. For example, there are waste sites in the 200-IS-1 OU that are suspected to contain concentrations of TRU radionuclides in excess of the 100 nCi/g concentration limit for designation as TRU waste. Waste sites containing concentrations of TRU radionuclides above 100 nCi/g may require selective removal actions or more protective barrier designs to prevent intrusion based on this particular hazard. Such alternatives might not be required for other process condensate or process waste sites within 200-IS-1 OU where only low-to-moderate levels of radionuclides are expected. Grouping waste sites with other similarly contaminated soil sites in other OUs could streamline the decision-making process and tailor the requirements and alternatives to these specific hazards.

Following the completion of the FS/closure plan, a proposed plan will be prepared that identifies the preferred remedial alternative for the OU. The preferred remedial alternative will include RCRA closure and corrective action requirements. In addition to identifying the preferred alternative, the proposed plan will serve the following purposes:

- Summarize the completed RI/FS.
- Provide criteria by which waste sites within the OU will be evaluated after issuance of the ROD to confirm that the contaminant distribution model for the site is consistent with the preferred alternative. Contingencies to move a waste site to a more appropriate waste group also will be developed.
- Identify performance standards and ARARs applicable to the OUs.

After the public review process is complete, the lead regulatory agency will make a final decision on the remedial action to be taken. The decision will be documented in a ROD. Ecology then will modify the Hanford Facility RCRA Permit to incorporate the ROD (and subsequent amendments) by reference, authorizing the RCRA actions.

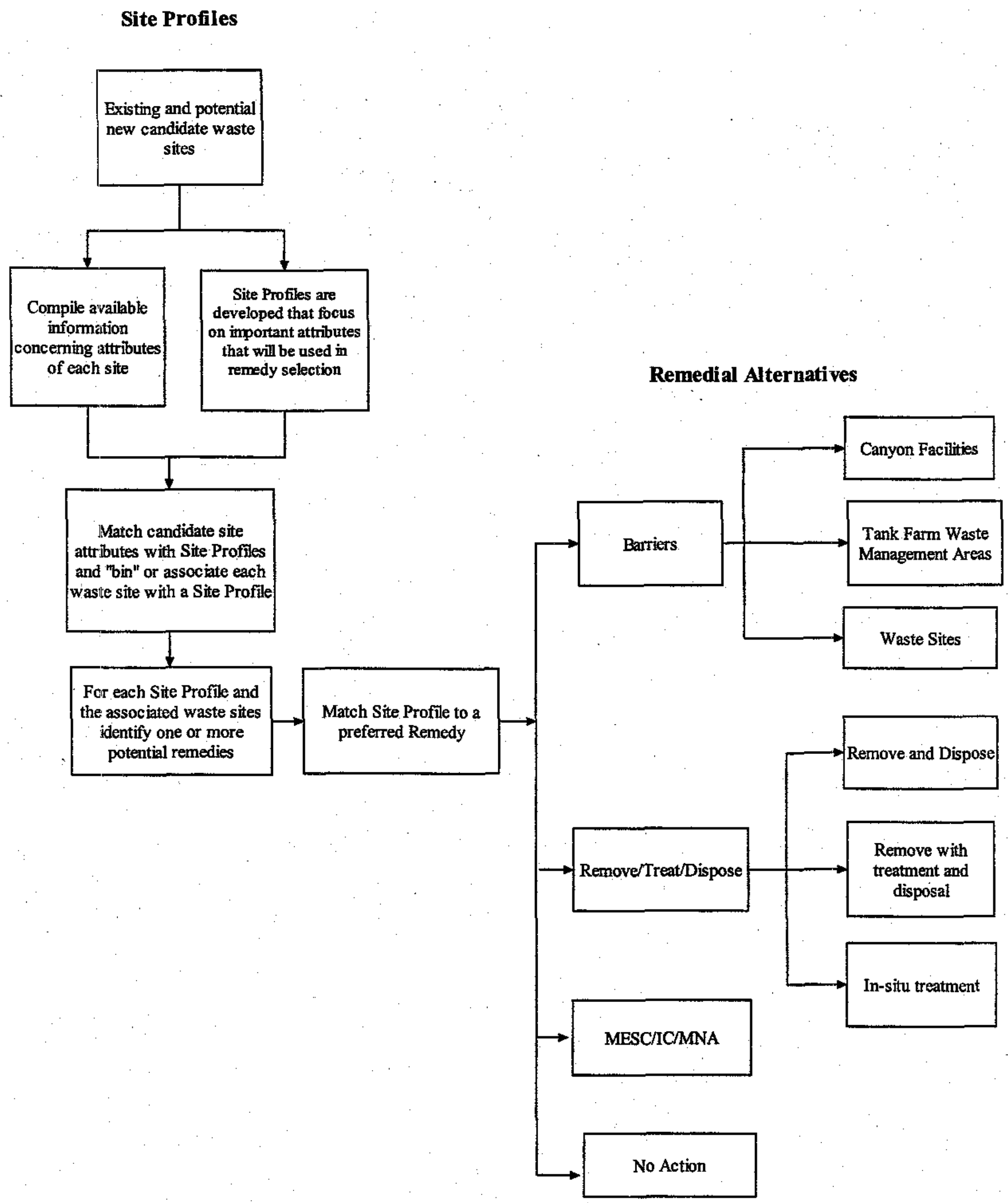
5.5 POST-RECORD OF DECISION AND/OR PERMIT MODIFICATION AND POST-CLOSURE ACTIVITIES

After the ROD and Hanford Facility RCRA Permit modification have been issued, a RDR/RAWP will be prepared to detail the scope of the remedial action, which will include RCRA closure and corrective action requirements. As part of this activity, DQOs will be established and SAPs will be prepared to direct confirmatory and verification sampling and analysis efforts. Before beginning remediation, confirmation sampling will be performed to ensure that sufficient characterization data are available to confirm that the selected remedy for the waste site is appropriate, to collect data necessary for the remedial design, and to support future risk assessments, if needed. Verification sampling will be performed after the remedial action is complete to determine if the ROD requirements have been met and if the remedy was effective. Additional guidance for confirmatory and verification sampling is provided in DOE/RL-98-28, Section 6.2.

The RDR/RAWP will contain an integrated schedule of remediation activities for the OU, including the schedule for RCRA TSD unit closures, and will satisfy the requirements for an RPP corrective measures implementation work plan and design report. Remediation activities will be designed to ensure integration of CERCLA cleanup activities and RCRA corrective actions and closure. Following the completion of the remediation effort, closeout activities will be performed as specified in the ROD, RDR/RAWP, and the RCRA Permit.

The RCRA closure activities and schedules will be defined in the closure plan and will be consistent with those identified in the RDR/RAWP. Enforceable sections of the closure plan will be identified in the Hanford Facility RCRA Permit modification. Certification of closure in accordance with WAC 173-303-610(6) will be performed after cleanup actions are complete. The site will be restored as appropriate for future land use. If clean closure is not attained at a TSD unit, post-closure care requirements will be met. These requirements will include final-status groundwater monitoring, maintenance and monitoring of institutional controls and/or surface barriers, and certification of post-closure at the completion of the post-closure.

Figure 5-1. Process Flow Diagram for Matching Site Profiles with Remedial Alternatives.



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6.0 PROJECT SCHEDULE

The project schedule for activities discussed in the pipelines, diversion boxes, and associated waste sites portion of this work plan is provided in Figure 6-1. This schedule will serve as the baseline for the work-planning process and will be used to measure the progress of implementing this work plan. The schedule concludes with the preparation of a ROD. The Hanford Facility RCRA Permit will be modified after the ROD is issued during Ecology's annual modification process.

The portions of this schedule most germane to this work plan are for the period of FY05 through FY08. One Tri-Party Agreement milestone that is associated with this work plan and the RI/FS process is Milestone M-15-00, "Complete RI/FS (or RFI/CMS) Process for All Operable Units (December 31, 2008)."

The following are proposed project milestone completion dates for key activities:

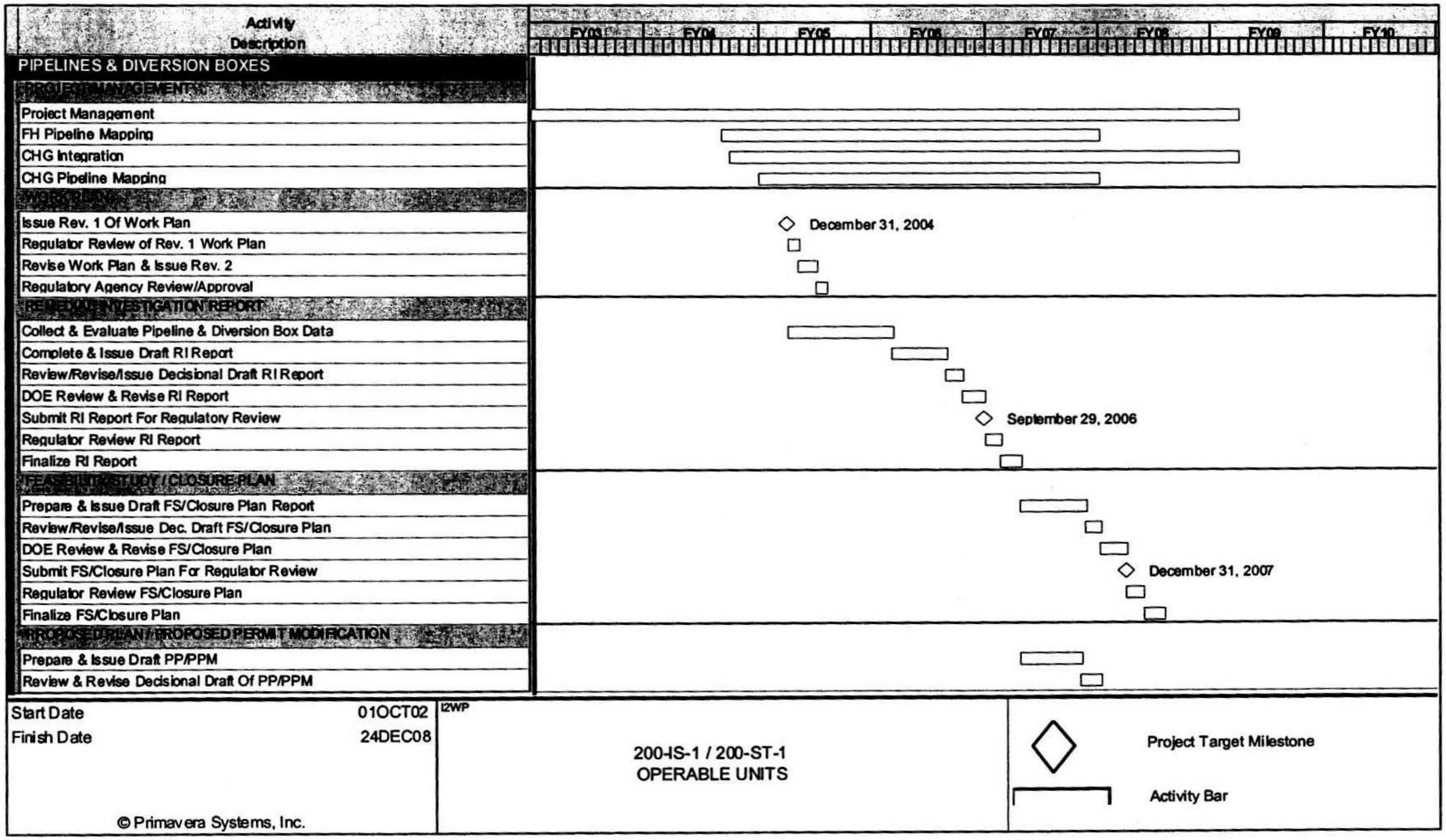
- Submit RI report for regulatory review: September 29, 2006
- Submit FS/closure plan for regulatory review: December 31, 2007
- Submit proposed plan/permit modification for regulatory review: December 31, 2007.

A single RI, FS, and proposed plan will be generated for all sites included in Parts II, III, and IV.

Interim milestones to be designated under the Tri-Party Agreement will be established through negotiations between DOE, Ecology, and EPA. A Class II change form will be submitted to Ecology and EPA to request the addition of any interim milestones.

The schedule also shows proposed timelines for related activities, specifically EE/CA and action memorandum activities for pipelines at the 200-UW-1 U-Plant Canyon Disposition Initiative (performed by RL and FH), and waste management area integration studies at the 241-C and 241-T Tank Farms (performed by ORP and CHG). These items are included for completeness and to show integration of RL and ORP activities. Milestones and schedules related to these activities are not considered to be part of the 200-IS-1 schedule.

Figure 6-1. Project Schedule for 200-IS-1 Pipelines and Diversion Boxes. (2 sheets)



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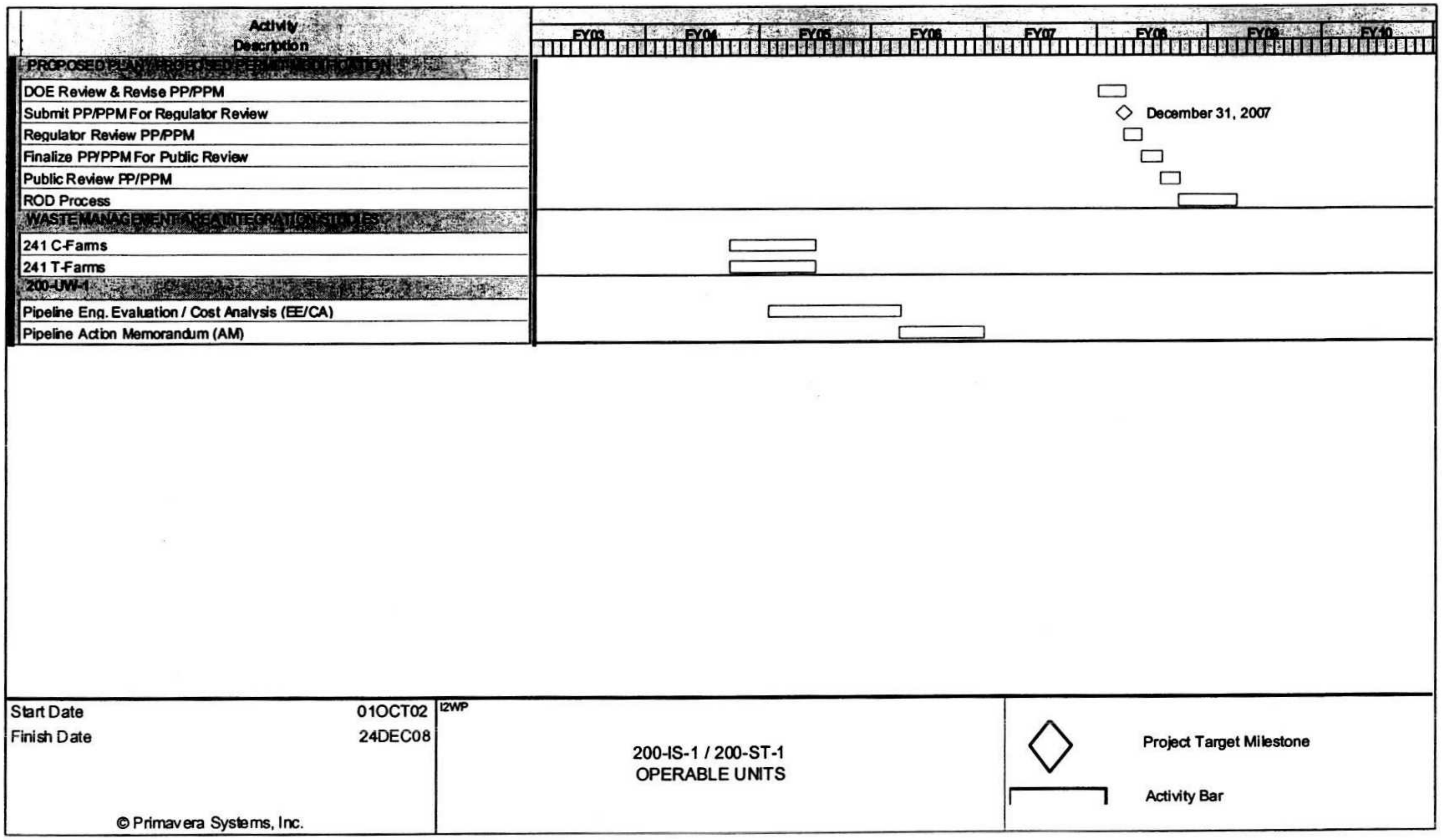

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